MAX-PLANCK-GESELLSCHAFT

Research Report 2001 - 2003

Max Planck Institute
for Human Cognitive and Brain Sciences
Department of Psychology, Munich

Research Report
2001 - 2003

Max Planck Institute
for Human Cognitive and Brain Sciences
Department of Psychology, Munich
(from January 1, 2004)

Max Planck Institute
for Psychological Research
(until December 31, 2003)

This report covers the period
from January 2001 to December 2003.

Amalienstr. 33
D-80799 Munich
Germany

Phone +49 (0) 89 / 38 602-0
Fax +49 (0) 89 / 38 602-199

contact.psy@cbs.mpg.de
www.cbs.mpg.de

Editors: Dr. Monika Nißlein and Dr. Frank Halisch
Assistance & Stylistic Revision: Heide John

Design: ARTelier Munich, Daniel Schwarz
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Continuity and change at the Institute in the period covered by the present report. Continuity is shown in the centre, with Edmund Wascher, Wolfgang Prinz and Gertrud Nunner-Winkler (back row) as well as Gisa Aschersleben and Ulrich Geppert (front row). Change is provided by Rafael Laboissière stepping in on the left and by Ralf Möller stepping out on the right.

Dear Reader,

The period covered by the present report is characterized by a number of truly significant events. To put it in philosophical terms, some of them pertain to matters of essence, while others touch upon matters of existence. By essence I refer to our research agenda as it becomes reshaped with old groups leaving and new groups coming in. By existence I refer to the Institute's long-term perspectives as a research institution of its own. Let me first turn to matters of essence.

- In fall 2001 Rafael Laboissière from Grenoble was appointed as Head of an Independent Junior Scientist's Research Group. This group was established within the framework of a joint program of the Max-Planck-Gesellschaft (MPG) and the Centre National de la Recherche Scientifique (CNRS). The focus of Dr. Laboissière's group is on *Sensorimotor Coordination*. The Unit resumed its work in 2002 and has since then started a novel research program, including several collaborations with other Units at the Institute.

- In spring 2003 Ralf Möller accepted a position as full professor in Technical Informatics, offered to him by the University of Bielefeld. He left the Institute in July 2003 – at a time when the research program of his Unit was in full flight. Part of this program is still being pursued at the Institute, but most of it will now be continued in Bielefeld. As much as we congratulate Ralf Möller on his new position, we regret the inevitable fading out of Cognitive Robotics at the Institute.

- In spring 2002 the Institute won a major grant for multidisciplinary studies on *Voluntary Action* (sponsored by the Volkswagen Foundation in the program on *Key Issues in the Humanities*). This project combines philosophical, sociological, and psychological studies on voluntary action, some of these studies being conducted at the Institute (including two projects in Philosophy of Mind). Further, we have established a number of collaborations with external scholars, including Thomas Goschke (Psychology/Dresden), Sabine Maasen (Sociology/Basel), Wilhelm Vossenkuhl (Philosophy/Munich) and Bettina Walde (Philosophy/Mainz).

Turning to matters of existence, the period covered by this report has witnessed a number of deliberations and discussions about options for the Institute's future. Recently some of these discussions have flowed into formal recommendations and decisions taken by the bodies of the Max Planck Society. As a result there is now good news and bad news. The bad news is that the Institute will cease to exist in Munich. The good news is that it will continue to exist in Leipzig as part of a larger institute. These big changes are going to happen in two major steps:

- In January 2004 a new Max Planck Institute will be founded, entitled *Max Planck Institute for Human Cognitive and Brain Sciences*. This new institute is created by merging two old ones: the Max Planck Institute for Cognitive Neuroscience (Leipzig) and the Max Planck Institute for Psychological Research (Munich). Eventually the new institute will be fully located in Leipzig, but for the next two to three years it will exist in two locations, Leipzig and Munich.

- In the summer of 2006 the Munich group will move to Leipzig, by which time it is expected that the Leipzig Institute will exhibit a novel scientific profile, consisting of five departments from various branches of the Human Cognitive and Brain Sciences.

Even if the good news makes us happy, the bad news makes us sad. Yet, despite these mixed feelings we realize that the merger of the two institutes brings unique opportunities for both of them. I am, in fact, convinced that this is by far the best and the most feasible move to make – in the interest of the two institutes and, what is more, in the interest of long-term perspectives for cognitive research.

In any case this is the last issue from our series of biannual research reports from the *Max Planck Institute for Psychological Research*. From Munich we say goodbye to everybody. See you next time in Leipzig.

Munich, December 2003

Wolfgang Prinz

Department:

Cognition & Action
(Wolfgang Prinz)

Research Units:

Infant Cognition and Action
(Gisa Aschersleben)

Cognitive Psychophysiology
(Edmund Wascher)

Cognitive Robotics
(Ralf Möller)

Sensorimotor Coordination
(Rafael Laboissière)

Moral Development
(Gertrud Nunner-Winkler)

Differential Behavior Genetics
(Ernst Hany and Ulrich Geppert)

Cognition & Action

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Introduction

Wolfgang Prinz

Our research addresses relationships between cognition and action. The focus of our agenda is on the cognitive processes involved in action planning, action control, and action perception as well as on mutual interactions between cognitive and action-related functions. One of our guiding ideas is that cognition and action are related to each other much more intimately than most theories of perception, cognition, and action believe. Notably, we hold that perception and action (or, perceived and intended events) share common representational resources.

Our research program can be seen from two perspectives. In one perspective, we adopt a functionalist stance on cognition, that is, we view cognitive functions in the service of action and study them in relation to the planning, execution, and perception of actions. In the other perspective, we adopt a cognitivist stance on action, that is, we view actions in the service of cognition and study their impact on cognitive operations.

Separate Coding

The traditional way of conceptualizing relationships between perception and action is in terms of two distinct processing systems: one for input processing; another, for output processing. On the input side, processing proceeds in a bottom-up manner. It starts with stimulus events in the world that lead to certain patterns of stimulation in sense organs, which, in turn, generate sensory codes in the brain. On the output side, processing takes a top-down direction. It starts with motor codes in the brain that lead to certain patterns of excitation in the muscles, with the effect that a physical movement is generated in the world.

The logic of separate coding implies that sensory codes and motor codes cannot communicate with each other directly. Instead, because sensory codes represent patterns of stimulation in sense organs and motor codes patterns of excitation in muscles, their contents are incommensurate. Accordingly, rule-based translation is required between the two. Indeed, the concept of translation is one of the most prominent notions in the literature to account for the mapping of responses to stimuli.

The philosopher René Descartes has provided us with a beautiful pictorial illustration of the logic inherent in separate coding. According to Descartes, perception meets action in the pineal gland where input mechanics is translated into output hydraulics. His view illustrates, in a nutshell, that perception and action are considered two separate and distinct functions of mental life.

Common Coding

Though separate coding has been the dominant view of relationships between perception and action, it has occasionally been challenged. The philosopher Ernst Mach has provided us with another famous illustration on perception and action. In Mach's perspective, actions are represented in the same way as external events, the only difference being that they can be controlled by will. Accordingly, since external events and actions are made of the same stuff, the planning of actions requires no translation between incommensurate entities. It rather implies interactions between certain events within a common representational domain for perception and action.

The common-coding approach holds that this notion applies not only to phenomenal experience (as Mach was claiming) but to functional mechanisms as well. Still, common coding is not meant to replace separate coding, but rather to complement it. Accordingly we posit, beyond and on top of separate systems for input and output processing, a common system for both in which output coding is commensurate with input coding.

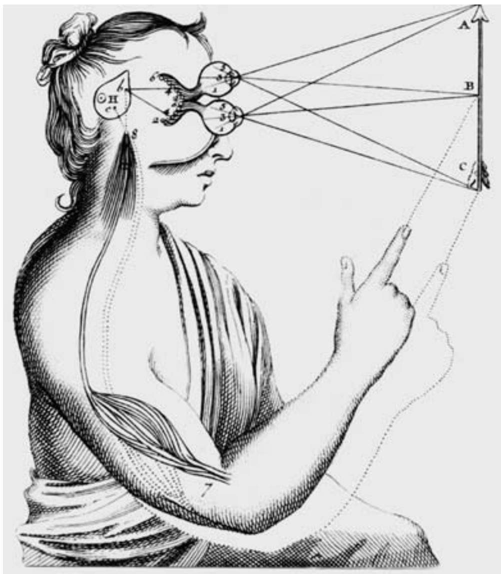

Figure 1: René Descartes used different metaphors for afferent and efferent condition, thus emphasizing the incommensurability between input and output coding. Afferent conduction is based on mechanical movement (pulling at certain nerve fibers), whereas efferent conduction is based on hydraulic pressure (dispensing neural liquid).

Theoretical Issues

Our research agenda is, of course, not meant to give full coverage to the fields of cognition and action. We rather focus on their intersection: on cognitive antecedents and consequences of action and action-related antecedents and consequences of perception and action. Our research is organized around a small number of *issues* that we address in a much larger number of experimental *projects*.

- **From perception to action: Action planning and control**
  How is perceptual information used for action planning and control? How are actions coordinated with environmental events? How is action planning affected by similarity between stimulus events and actions (as in stimulus-response compatibility, imitation, sensorimotor synchronization etc.)?

- **From action to perception: Perception of actions and events**
  How is perception affected by intended or ongoing action? What role is played by similarity between perception and action? Does it help or hurt? To what extent does action perception rely on action production? Do action perception and production draw on common resources?

- **From actions to goals: Anatomy of action representation**
  How are cognitive representations of actions formed? What is their informational basis and how are they assembled? What role do body movements and more remote action effects play in these representations? How do action effects become integrated into action codes? How can representations of action effects take the role of action goals?

- **From goals to actions: Mechanisms of voluntary action**
  How is intentional control of action instantiated, and how does it interact with perceptual control? How are conscious intentions related to nonconscious mechanisms? How are task sets represented and maintained? How do tasks interact that follow each other (task switching)? How do tasks interact that address the same information at the same time (task interference)?

Neither separate nor common coding has ready-made answers to offer to any of these questions. What the frameworks offer are general principles, not specific theories. Accordingly, the principle of common coding should be seen as a general heuristic guideline for constructing more specific theories that then may help answer more specific questions pertaining to more specific task environments.

Experimental Projects

Obviously, there can be no simple 1:1 mapping of projects to issues. Instead, as will become apparent below, most projects address more than one issue. Further, most tackle not only the issues raised so far but also more specific paradigm-related issues in their respective research traditions.

Accordingly, our report is organized in terms of projects, and we let issues play the role of recurrent themes to which we return time and again. Our report is organized in the five sections:

- **Perceiving actions and events**
- **Coordinating actions and events**
- **Interference between actions and events**
- **Planning and control of actions and events**
- **Expertise and acquisition of action and event structures**

Figure 2: Ernst Mach believes that the body is perceived in exactly the same way as the environment, thus emphasizing the continuity and commensurability between bodily actions and external events.

Section 1: Perceiving Actions and Events

Günther Knoblich, Andreas Wohlschläger, Patric Bach, Jochen Müsseler
Kai Engbert, Gisa Aschersleben, Wolfgang Prinz

Introduction

The traditional view of incommensurable codes pertaining to perception and action has been challenged by research showing that past, current, or upcoming actions leave traces in our perceptual experience. A common-coding perspective, in contrast, predicts that all stages of an action may have repercussions in perceptual tasks and vice versa (cf. Hommel, Müsseler, Aschersleben & Prinz, 2001). An example from everyday life may illustrate this point: Typically, we drink coffee from a mug. However, when we are holding a bunch of flowers and are looking for a vessel to put them into water, a coffee mug that happens to be within our reach may be turned into a vase. Importantly, what we intend to do with the object may change the object properties we attend to. Instead of focusing on the handle of the object, which is what we usually do when we drink coffee from the mug, we focus on its aperture—which we need to do when we put the flowers' stems into the mug. Thus, intended actions determine which object attributes are selected. Further, our intended actions may well change the way we judge the attribute. In the case of drinking coffee, the aperture may be judged as large, but when we try to put the flowers into the mug, it may seem rather small. This suggests that intended or executed actions change the way in which we perceive the world.

The idea that action is important for perceptual processes is not entirely new. In the late 1980s, researchers in the field of attention proposed an alternative explanation for our inability to process large numbers of items in a parallel manner. The new idea at that time was that our motor behavior would result in chaos if it was fed with all the information available. Attention was thought to select information for action. The "selection-for-action" hypothesis was groundbreaking, because it provided a functional reason for a property of vision that was related to the motor system. Previously, the two systems had been treated as if they were independent. Here, we make the much more radical claim that perception and action are functionally dependent because they share mechanisms and representational codes.

Projects

Starting with the intention to perform the action and ending with motor programs representing a previously performed action in memory, event codes are expected to modulate motor performance and perceptual awareness. In particular, the ongoing planning and execution of an action may change the perceived location of events, the perceived features of events, and the perceived timing of events. The projects are roughly organized in terms of the complexity of the perceptual processing involved.

Before executing an action, the intention to perform it has to be established. For saccades, this may be an automatic process triggered by the abrupt onset of a stimulus. However, saccadic planning often errs in that the amplitude of the saccade is shorter than the actual distance to the target. This undershoot is mirrored in perceptual judgments, that is, a target is perceived to be closer to the fovea than it actually is. To explain these similarities, the project area **Localizing Briefly Presented Stimuli** pursues the hypothesis that the distorted metrics of saccade programming underlie perceptual judgments.

Not only the preparation but also the execution of eye movements affects perceptual judgments. In a well-known illusion, observers mislocalize the final position of a moving object in the direction of motion. Previous theorizing attributed this error to mental processes continuing the stimulus motion in memory. The project **Representational Momentum** makes the alternative suggestion that eye movements executed after the moving target has disappeared account for this illusion.

Further, the project area **Temporal Priming of Perceptual Events** asks whether identical stimulation can influence perceptual judgments and actions in different ways. A direct route between stimulus identification and action produces fast responses in simple responses, whereas more complex choice reactions and synchronization performance are based on later integrative processes. These findings may sharpen our understanding of differential links between perception and action.

In the project area **Perceived Timing of Events**, we investigated the perceived timing of actions and associated stimulus events. We demonstrated that the ongoing planning and execution of an action changes the perceived timing of a related event as well as the reverse phenomenon: The perceived timing of a performed action is influenced by an associated event preceding or following the action.

The project area **Perception of Self and Other** explores differences between the perception of self-produced actions and other-produced actions. One line of research aims at determining whether observing one's own past actions differs from observing somebody else's actions. The second line of research attempts to identify the cognitive and brain systems that support the identification of one's own actions in the perceptual input. Third, it is investigated whether the temporal awareness of one's own action differs from that of others' actions. A further consequence of the common-coding assumption is that the perception of actions and events will activate the common representations as soon as an observed event is "do-able" by the action system. Hence, relevant information residing in the motor system may be made available for the perceptual system through common event representations. The project is concerned with one implication of this assertion: The similarity between external events and the common event representations should be higher when observing actions and events produced by oneself (e.g., on a video displaying one's own rather than a friend's actions). The project investigates whether one's own actions have a special status in action perception.

In sum, the projects in this section provide evidence for the view that (1) perception can be affected by ongoing action, (2) action perception and action production draw on common resources, and (3) action perception, at least in part, relies on action production. This suggests that a linear stage model which draws upon a clear-cut distinction between perception and action cannot be upheld.

The ongoing planning and execution of an action may change the perceived location of events, the perceived features of events, and the perceived timing of events.

1.1. Localizing Briefly Presented Stimuli

Dirk Kerzel
Jochen Müsseler
Sonja Stork

For an illustration of the relative mislocalization, visit the web page: www.psy.mpg.de/~muesseler/FlashEffect/FlashEffect.html

The present subprojects are concerned with the question how accurately participants are able to localize briefly presented stimuli. The projects address several perceptual phenomena with stationary and moving stimuli and try to demonstrate whether and how these phenomena are – at in part – influenced by the perception-action interface (cf. Müsseler, van der Heijden, & Kerzel, in press a, b).

Localizing Stationary Stimuli

In this project the ability to localize successively flashed stimuli is studied with a *relative* judgment task. When observers are asked to localize the peripheral position of a probe with respect to the mid-position of a spatially extended comparison stimulus, they tend to judge the probe as being more outer than the mid-position of the comparison stimulus (Müsseler et al., 1999, *Percept Psychophys, 61,* 1646-61). This relative mislocalization seems to emerge from different *absolute* mislocalizations, that is, the comparison stimulus is localized more foveally than the probe in an absolute judgment task. Comparable foveal tendencies in absolute localizations were observed in our lab with an eye-movement task (Stork & Müsseler, 2002; Stork, Müsseler, & van der Heijden, subm.) and a pointing task (Kerzel, 2002a).

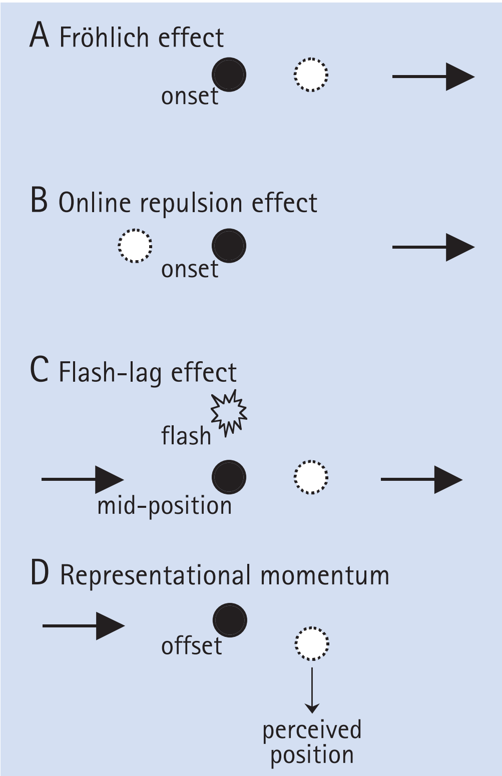

Figure 1.1.1: When observers are asked to localize the position of the onset (A) or the offset (D) of a moving target, they typically make localization errors in the direction of movement (Fröhlich effect and representational momentum). Similarly, when observers judge a moving target that is presented in the mid-position in alignment with a flash (C), the target appears to lead the flash (flash-lag effect). In the onset repulsion effect, the opposite localization error is observed (B).

Further experiments revealed that this mislocalization emerges with both a bilateral and unilateral presentation mode – with the latter mode, however, only if probe and comparison stimulus are presented in succession. Among other dependencies, the size of the mislocalization is influenced by the eccentricity of presentation and by figural features of the stimuli. The results are related to comparable tendencies observed in eye-movement behavior and it is concluded that the system in charge of guiding saccadic eye movements is also the system that provides the metric in perceived visual space (Müsseler & van der Heijden, in press).

Localizing the Onset of Moving Stimuli

In the *Fröhlich illusion*, judgments of the onset position of a moving object are typically displaced in the direction of motion (Figure 1.1.1). In previous studies we developed and found evidence for an attentional account according to which the onset of the stimulus initiates a focus shift towards it and – while this shift is underway – the stimulus continues to move. The stimulus was assumed to be perceived at some later position, because the end of the focus shift determines the first consciously perceived position.

So far, the Fröhlich illusion has been obtained with linear motion of a small target (for an overview, see Müsseler & Aschersleben, 1998, *Percept Psychophys, 60,* 683-95) or with rotary motion of a spatially extended line (Kirschfeld & Kammer, 1999, *Vis Res, 39,* 3702-9). In a series of experiments, judgments of the initial orientation of a small rotating dot were directly compared with a line that rotated around the point of fixation. Surprisingly, the illusion was absent with the dot, whereas it was reliably obtained with the line. When the density of the line was reduced to two dots, the illusion persisted. However, the illusion was absent when a half-line extending to only one side from fixation was presented. We interpret the results with respect to attentional accounts of the Fröhlich illusion: The single dot attracted focal attention, whereas the line did not. Also, localization performance may differ between tasks requiring judgments of stimulus amplitude and of stimulus direction (Kerzel & Müsseler, 2002).

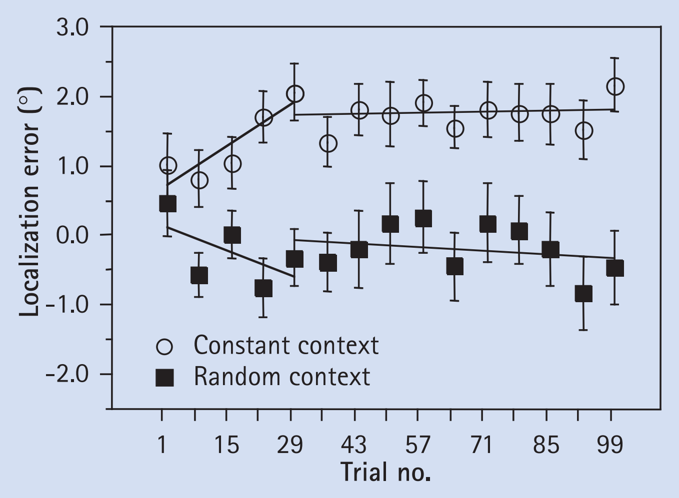

Figure 1.1.2: Mean localization errors of the first position of a moving stimulus. Localizations of the perceived onset position vary with the trial context: When the stimuli appeared at predictable positions (constant context), pointing responses to the perceived onset position were displaced in movement direction. In contrast, when the stimuli appeared at unpredictable positions (random context), pointing responses were displaced opposite to motion.

Reconciling the Fröhlich and Onset Repulsion Effects

Contrary to the Fröhlich effect, recent studies have also revealed a localization error which is always back along the observed path of motion (*onset repulsion effect;* cf. Thornton, 2002, *Spatial Vis, 15,* 219-43). We demonstrate that the conflict between these findings is resolved by considering the trial context: When the stimuli appeared at predictable positions to the left or right of fixation, pointing responses to the perceived onset position were displaced in movement direction. In contrast, when the stimuli appeared at unpredictable positions in the visual field, pointing responses were displaced opposite to motion. Thus, localizations of the perceived onset position vary with the trial context (cf. Figure 1.1.2; Müsseler & Kerzel, subm.; see also Kerzel, 2002b; Kerzel & Gegenfurtner, subm.).

Comparing Mislocalizations in Movement Direction

Apart from the Fröhlich effect there are two further well-established illusions in movement direction. They are observed when participants localize the *offset* position of a moving target (*representational momentum*, see also the subsequent section) or when they judge a moving target that is presented in alignment with a flash *(flash-lag effect).* This study compared the size of the three mislocalization errors. In Experiment 1, a flash appeared either simultaneously with the onset, the mid-position, or the offset of the moving target. Observers then judged the position where the moving target was located when the flash appeared. Experiments 2 and 3 are exclusively concerned with localizing the onset and the offset of the moving target. When observers localized the position with respect to the point in time when the flash was presented, a clear mislocalization in the direction of movement was observed at the initial position and the mid-position. In contrast, a mislocalization opposite to movement direction occurred at the final position. When observers were asked to ignore the flash (or when no flash was presented at all), a reduced error (or no error) was observed at the initial position and only a minor error in the direction of the movement occurred at the final position. An integrative model is proposed, which suggests a common underlying mechanism, but emphasizes the specific processing components of the Fröhlich effect, flash-lag effect and representational momentum (Müsseler, Stork, & Kerzel, 2002).

Subprojects of this area were supported by the Deutsche Forschungsgemeinschaft (DFG grant AS 79/3).

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1.2. Representational Momentum – A Case of Observer Action

Dirk Kerzel
Jochen Müsseler
Sonja Stork

Parts of this research have been conducted in cooperation with J. Scott Jordan (Illinois State University), Sebastiaan F. Neggers (University Utrecht, NL) and Lothar Knuf.

It has been suggested that the position of moving objects is extrapolated in visual short-term memory. After offset of a moving target, extrapolation displaces the remembered final target position into the direction of motion. A cognitive approach holds that forward displacement (FD) of the final position of a moving target results from the inability to stop extrapolation instantaneously *(representational momentum)*. However, more recent studies show that FD strongly depends on the methods, stimuli, and responses used.

Effects of Motion Type

To investigate FD of the final target position, some authors used linear, smooth target motion that resembled real natural motion (see Figure 1.2.1 D). Smooth motion on a monitor is created by shifting the target from one position to the next at a very high frequency such that the stimulus onset asynchrony (SOA) between successive target presentations is small. With linear smooth target motion, pursuit eye movements are very likely. After smooth pursuit of a moving target that suddenly disappears, the eyes overshoot the final target position, and this overshoot explains the localization error (Kerzel, 2003b; Kerzel, Jordan, & Müsseler, 2001; Stork, Neggers, & Müsseler, 2002).

In contrast, other authors used implied rotational or linear motion and reported reliable FD (see Figure 1.2.1 A-C). To create implied motion, the target position is changed infrequently, and blank intervals are inserted between successive target presentations. In a large number of studies on *representational momentum*, the target was shown in one position for 250 ms, and after a 250 ms blank interval it was shown in the next position. Thus, the SOA between successive target positions was 500 ms, which gives the impression of a target appearing at different locations. With implied motion, pursuit eye movements and subsequent oculomotor overshoot are highly unlikely, and a recent study reported no systematic dependency of FD on eye movements: When eye movements were measured during a sequence of implied motion, no systematic relation between shifts of fixation and FD was revealed (Kerzel, 2003a).

To resolve this conflict, the SOA between successive target positions was gradually increased (Kerzel, in press). Implied motion is characterized by large SOAs on the order of 500 ms, whereas smooth motion is characterized by SOAs smaller than 30 ms. The main result was that there is an increasing function relating SOA and FD. That is, FD was strong when the SOA was long. This result is unexpected for most models of position perception, because there is ample time to integrate position information with the longest SOA. Therefore, any errors due to temporal integration should be smaller for long SOAs. However, the opposite was the case: Localization of stimuli that were presented at the same position for about 300 ms was less accurate than that of stimuli presented for about 25 ms only.

Maybe the most obvious interpretation for the effect of SOA is mental extrapolation: Observers (involuntarily) extrapolate the next position of the stimulus sequence after target offset and this overtracking of target positions leads to the error. For long SOAs, the next step in the sequence is larger than for small SOAs (i.e., 2° with a SOA of 565 ms, 1° with a SOA of 282 ms, etc.). After extrapolating to the next step in the sequence, one may assume that observers compensate for this overshoot. That is, observers know that they have been asked to judge the final target position and not the next logical step in the sequence. The crucial assumption is that observers only compensate for part of the extrapolated distance such that judgments are biased toward the extrapolated position. Because the extrapolated distance increased with SOA, an increase of FD with SOA would result. Consistent with this assumption, response times increased with SOA as if observers imagined the next target step before responding. Also, it was observed that attention moved to the next step in the sequence such that reaction times to probe stimuli which appeared ahead of the final target position were fastest (Kerzel, 2003a).

Effects of Response Mode

Another discrepancy between studies on FD that used smooth and implied motion is the response mode. Whereas probe judgments were used in Freyd's original work that used implied motion, later investigators also used (mouse) pointing responses. A recent study has shown that there are differences between probe and motor judgments (Kerzel, in press). Generally, FD is larger with motor responses than with probe judgments. In some respect, this finding contradicts the view that

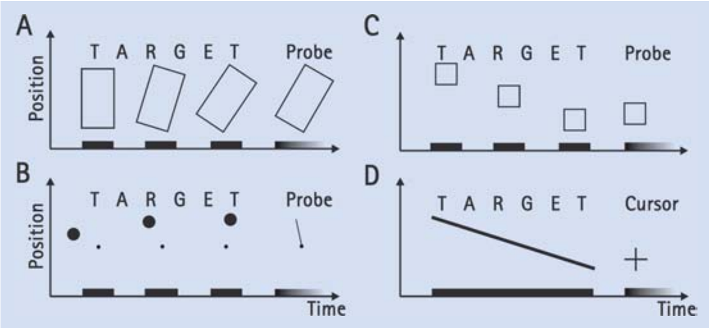

Figure 1.2.1: Different methods used to study representational momentum. Panel A: A target rectangle was presented three times at the same position on the screen. Between successive presentations, the target was blanked and rotated. After the final target view, a probe rectangle was shown and observers were asked to indicate whether the probe was at the same orientation as the final target rectangle. Panels B and C: Variants of the method shown in panel A. Panel C: The target changes its position continuously without noticeable jumps. As it is continuously visible, the impression of smooth motion is conveyed. After target offset, observers are asked to indicate the final position by moving a cursor to the final target position.

pointing movements have access to more veridical spatial information than probe judgments (e.g., Bridgeman et al., 1979, *JEP:HPP, 5(4),* 692-700). In fact, pointing movements were shown to be less accurate than probe judgments in some conditions. However, the present results support the notion of distinct processes or representations serving motor actions and cognitive judgments. Possibly the motor system anticipates future positions to a larger degree than the visual system. Thus, motor extrapolation may overcome processing delays inherent in the visual system.

Perceptual Set

In most studies that have looked into FD with implied motion, the length of the trajectory was fixed, and observers knew where the target would appear and vanish before a trial started. Without eye movements, expectations about what an observer would see on a given trial may be manipulated by using different designs (Kerzel, 2002a). Both motion direction and the target's starting position were treated either as fixed or random variables. It turned out that FD was eliminated when both the target's starting position and motion direction were unpredictable. Thus, it is possible that expectations about the target's motion that developed across trials (i.e., perceptual set) contribute to FD (see also Jordan, Stork, Knuf, Kerzel, & Müsseler, 2002). Similarly, pursuit eye movements of a smoothly moving target are affected by expectations. The velocity of the eye is reduced when changes in the direction of target motion are anticipated (Kerzel, 2002c; Stork, Neggers, & Müsseler, 2002; Stork & Müsseler, in press). Target localization reflects this change in eye velocity.

Attention

When attention was captured by irrelevant distractors presented during the retention interval, FD after implied target motion disappeared, suggesting that attention may be necessary to maintain mental extrapolation of target motion (Kerzel, 2003a). Also, faster responses were observed to those stimuli appearing in the direction of motion. Thus, attention may guide the mental extrapolation of target motion. Further, shifts of attention occurring at unpredictable times may bias localization of target position (Kerzel, 2002b). When observers are asked to localize the final position of a moving stimulus, judgments may be influenced by additional elements that are presented in the visual scene. Typically, judgments are biased toward a salient non-target element. However, an influence was only observed if the distractor was presented at the time of target disappearance, or briefly afterwards. It is suggested that memory traces of distracting elements are only averaged with the final target position if they are highly activated at the time the target vanishes.

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Kerzel, D. (2002a). A matter of design: No representational momentum without expectancy. *Visual Cognition, 9(1-2),* 66-80.

Kerzel, D. (2002b). Attention shifts and memory averaging. *The Quarterly Journal of Experimental Psychology. Section A: Human Experimental Psychology, 55A(2),* 425-443.

Kerzel, D. (2002c). The locus of 'memory displacement' is at least partially perceptual: Effects of velocity, expectation, friction, memory averaging, and weight. *Perception & Psychophysics, 64(4),* 680-692.

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1.3. Temporal Priming of Perceptual Events

Gisa Aschersleben
Jochen Müsseler
Sonja Stork

This research was partially supported by a grant from the Deutsche Forschungsgemeinschaft (DFG grant AS 79/3). Part of the project has been conducted in collaboration with Talis Bachmann, Tallinn, Estonia.

In the literature, temporal dissociations between perceptual judgment and motor behavior are mainly observed between temporal order judgments (TOJ) and simple reaction-time tasks (SRT; Aschersleben, 2001). We extended these studies by applying various perceptual and motor tasks (localization judgment, TOJ, SRT, choice reaction (CRT), and synchronization tapping) to different phenomena, namely the Fröhlich effect (Aschersleben & Müsseler, 1999, *JEP: HPP, 25,* 1709–20), the kappa effect, and metacontrast. The present subprojects tested the temporal priming idea, that is, we assumed that a preceding stimulus (occurring in spatial proximity) influences the perceived timing of a subsequent stimulus. This predating of a subsequent stimulus is supposed to be caused by attentional mechanisms.

Task-Dependent Timing of Stimuli in the Kappa Effect

In the kappa effect time estimates of stimuli are influenced by the spatial context of the stimulus configuration. It occurs when a person has to judge the two intervals between a sequence of three stimuli presented at different spatial intervals. A greater distance between two stimuli makes the corresponding time interval also appear to be longer (Huang & Jones, 1982, *Percept Psychophys, 32,* 7-14). By applying CRT we were able to show that this effect is at least partly due to an influence of the preceding stimulus on the timing of the subsequent one while the timing of the first stimulus presented is not influenced by the subsequent stimulus (priming hypothesis, cf. Figure 1.3.1). The results demonstrate that the attentional focus is not spatially limited to the position of the stimulus that elicits the attentional shift although its position is relevant (spatial and temporal priming, Figure 1.3.2; Aschersleben & Müsseler, subm.).

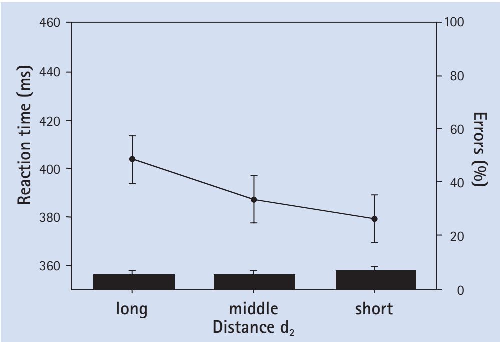

Figure 1.3.1: Kappa effect: Three stimuli were presented at different spatial distances with d_1+d_2=const. d_1: distance between the first two stimuli; d_2: distance between the second and the third stimulus. Mean RT and percentage of errors in the choice reaction-time task on the third stimulus as a function of the second spatial distance (d_2).

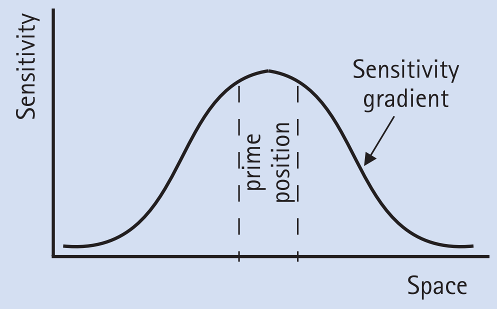

Figure 1.3.2: Spatial distribution of the sensitivity gradient caused by the prime. The effect of the prime eliciting the attentional shift is not spatially limited to the position of the prime but follows an assumed sensitivity gradient, which is reduced with increasing spatial distance to the prime.

Task-Dependent Dissociations in the Timing of Stationary Stimuli

In metacontrast, the visibility of a stimulus (test) is reduced by a subsequent, spatially proximal stimulus (mask). However, the motor reaction remains unaffected by the masking (Fehrer & Raab, 1962, *JEP, 63,* 143-7). A series of experiments applied the metacontrast paradigm to present pacing signals in a synchronization task (cf. Section 2.1). Results indicated a predating of the mask by the previously presented test. However, when instructed to synchronize with the test, there was no dependence on the SOA between test stimulus and mask. Similar findings were observed for conditions in which the test was unmasked indicating that the priming of the second stimulus is a more general principle, which is independent of the visibility of the first stimulus (Aschersleben & Bachmann, subm.). Supporting evidence for the priming hypothesis comes from studies using the temporal order judgment task.

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1.4. Perceived Timing of Events

Gisa Aschersleben
Wolfgang Prinz

Binding in Perceived Timing of Stimuli and of Actions

The perceived times of actions and associated stimulus events was investigated by using the classical Libet paradigm (Libet et al., 1983, *Brain, 106,* 623-42). Results indicated that the perceived time of events depends on whether these events are consequences of a self-generated action (action effects) or whether they occur by themselves. In general, events are judged earlier if they are action effects (see Figure 1.4.1). When a stimulus elicits an action, or when an action produces a stimulus, the perceived time of the events shifts as a result of the sensorimotor context in which they occur. These shifts represent attraction effects between the percepts of stimuli and of movements. They are consistent with an efferent binding process linking representations of stimulus events and of actions. The effects were comparable across stimulus and action percepts, and across different tasks. Therefore, the underlying binding process appears to be quite general. Moreover, we were able to show that the effects occur only when stimuli and actions are linked in a causal context and do not occur in mere repetitive sequences of stimuli and actions. Thus, our effects can be attributed to a specific process governing the representation of interactions between the subject and the external world, rather than a general process of time or sequence perception (Haggard, Aschersleben, Gehrke, & Prinz, 2002).

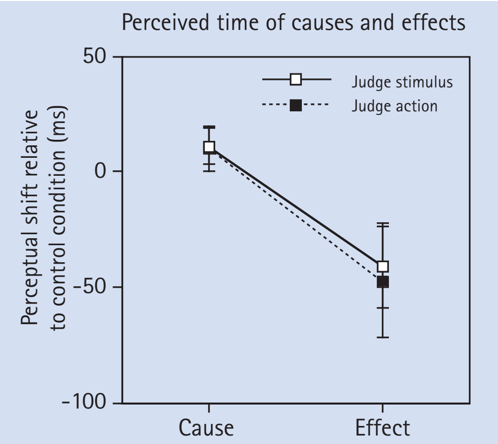

Figure 1.4.1: Perceptual shifts categorized by causal status in four different tasks. SjA: Judge time of a beep to which participant responds; AjS: Judge time of a willed operant action which is followed by a beep; SAj: Judge time of response to a beep; ASj: Judge time of beep elicited by willed operant action.

Crossmodal Interaction in the Perceived Timing of Events

Crossmodal interaction is usually known to occur in the spatial domain. For example, in the ventriloquist effect, auditory and visual events presented in separate locations appear closer together. By applying the staircase method the first part of studies in this project ruled out the explanation that judgment errors are responsible for such effects. Moreover, results indicated that a strict synchrony between auditory stimulus and visual distractor is a precondition for the effect to occur (Bertelson & Aschersleben, 1998, *Psychon B Rev, 5,* 482-9). In the second part of this project, we considered the possibility of the converse phenomenon: crossmodal attraction on the time dimension conditional on spatial proximity. Participants judged the temporal order of sounds and lights separated in time and delivered either at the same or at different locations. By again using the staircase method we showed that impressions of temporal separation are systematically influenced by spatial separation. This finding supports a view in which timing and spatial layout of the inputs play to some extent symmetrical roles in bringing about crossmodal interaction (Bertelson & Aschersleben, 2003). Converging evidence is also available from synchronization experiments in which participants were confronted with two pacing signals (one visual and one auditory), but had to pay attention to only one of them for the actual synchronization task. Whereas with spatially discrepant stimuli the distortion of the localization of auditory stimuli through discrepant visual stimuli is greater than vice versa, the temporal domain reveals clear dominance of the auditory modality (Aschersleben & Bertelson, 2003).

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The project Binding in Perceived Timing of Stimuli and of Actions was conducted in collaboration with Patrick Haggard, University College London.

The project Crossmodal Interaction in the Perceived Timing of Events was conducted in collaboration with Paul Bertelson, Free University of Brussels, Belgium.

1.5. Perception of Self and Other

Kai Engbert
Rüdiger Flach
Günther Knoblich
Wolfgang Prinz
Andreas Wohlschläger

This project explores differences between the perception of self-generated actions and other-generated actions. The first line of research aims at determining whether observing one's own past actions differs from observing somebody else's actions. The second line of research attempts to identify the cognitive and brain systems that support the identification of one's own actions in the perceptual input. The third line of research investigates whether the temporal awareness of one's own action differs from that of others' actions.

Action Identity

The common-coding theory provides a principle for how one can match actions that one observes others doing to one's own action repertoire. The more similar an observed action is to the codes that govern one's own action planning, the higher the activation of these codes. This similarity principle seems to imply that common codes should be more activated when observing one's own past actions than when observing others' actions (Knoblich, 2003; Knoblich & Flach, 2003). The reason is that there are interindividual differences in performing actions. For instance, people have different ways of walking, throwing, writing, etc. Thus, whenever one perceives one's own past actions, the similarity between the perceptual events observed and the common event representation should be high, because one perceives a sequence of events one would produce in the same way. If one perceives others' actions, the perceptual events observed and the common event representations should be less similar. This difference in activation should allow one to identify one's own past actions.

The studies on self-recognition of expert pianists were conducted in cooperation with Bruno Repp at Haskins Laboratories, Newhaven, Connecticut, USA.

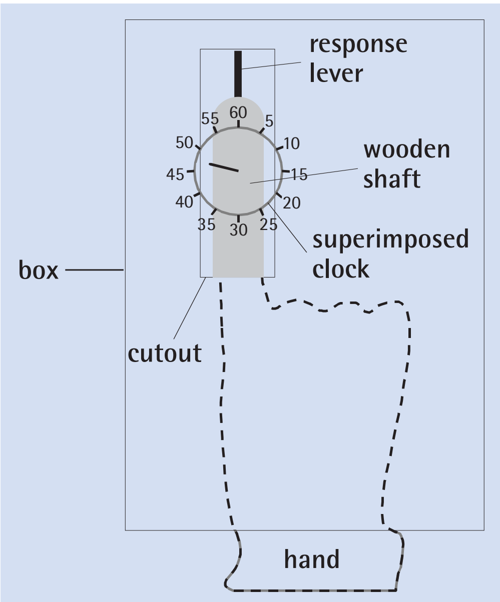

Figure 1.5.1: Experimental technique. Either the participant's hand, the experimenter's, or a rubber hand was placed into a wooden box so that the index finger of the hand slipped into a wooden shaft which was fixed to a response lever. Through a cutout on top of the box, the shaft and the lever were visible. Participants viewed the box through a semi-silvered mirror, which served to superimpose the clock on the wooden shaft. The clock-hand started to rotate at a random position with a constant angular speed of 140°s-1. After the lever was depressed, the clock-hand continued to rotate for random period between 1.5 and 2.5s thereafter. Using the minute scale, participants then reported the estimated position of the clock-hand at the moment of lever depression.

This prediction was first confirmed in the writing domain. Individuals could identify their own writing from point-light displays (Knoblich & Prinz, 2001). In the meantime, we have addressed self-recognition of one's past actions in the auditory domain as well. In one series of experiments, we recorded the clapping of a number of participants and replayed their own clapping to them, together with the clapping of other individuals, about a week later (Flach, Knoblich, & Prinz, in press). The individuals were able to reliably identify their own clapping based on its tempo and rhythm. A further series of experiments addressed self-recognition in expert pianists. They identified their own piano-playing extremely well, even if the pieces were unfamiliar and played without feedback (Repp & Knoblich, in press).

Further studies addressed the assumption that individuals are better able to predict the future outcomes of their own past actions than those of others' actions. In one study individuals were able to more accurately predict the future course of writing trajectories when they were self-generated (Knoblich, Seigerschmidt, Flach, & Prinz, 2002). In another study individuals were able to more accurately predict the landing position of a dart when they observed their own throwing actions (Knoblich & Flach, 2001). The results of a further series of experiments provided a first indication that one might also be able to better coordinate new actions with one's own past actions (Flach, Knoblich, & Prinz, 2003). Together, the studies on action identity provide evidence that individuals do not only recognize their "action style", but that they can also generate more accurate predictions of future action outcomes based on their past actions.

Cognitive and Brain Systems Underlying Action Identification

In this project we address the question how one recognizes the consequences of one's own actions in the perceptual input while performing them (Knoblich, 2002). One possible assumption is that forward models in the action system predict and attenuate the perceptual consequences of one's own actions. Evidence for this claim has been provided in the tactile domain (Blakemore, Wolpert, & Frith, 1998, *Nature Neurosci, 1*, 635-40). We conducted an fMRI study to test whether similar mechanisms are present in the visual domain (Leube, Knoblich, Erb, Grodd, Bartels, & Kircher, 2003). Participants opened and closed their hand slowly and continuously (0.5 Hz). This movement was filmed with an MRI-compatible video camera and projected online onto a screen viewed by the subject. The temporal delay between movement and feedback was parametrically varied (0-200ms). There was a positive correlation between the extent of temporal delay and activation in the right posterior superior temporal cortex (pSTS), and a negative correlation in the left putamen. This pattern of results is consistent with the assumption that forward models in the putamen attenuate sensory areas for movement processing. In a further fMRI study we investigated which brain systems detect mismatches between the actions one plans and the consequences one observes (Leube, Knoblich, Erb, & Kircher, 2003). This study further confirmed the claim that a left fronto-parietal network underlies the ability to detect such mismatches.

Temporal Awareness of Self- and Other-Generated Actions

Awareness of actions is partly based on the intentions accompanying them. Thus, the awareness of self- and other-generated actions should differ to the extent the access to own and other's intentions differs. However, we have recently shown that the estimated onset time of actions is similar for self- and other generated actions, but different from similar movements executed by a machine or rubber hand (Wohlschläger, Haggard, Gesierich, & Prinz, 2003). Further investigations showed that the similarity in the awareness of self- and other-generated actions (button presses in our experiments) critically depends on the presence of a distal action effect (typically a beep following the button press after 250 ms). Actions with a distal effect lead to a shift of the estimated onset time towards the effect (Haggard, Aschersleben, Gehrke, & Prinz, 2002). If the action is void of an effect, the temporal awareness of self- and other generated actions is no longer similar and self-generated actions are estimated to happen earlier than those of others (Wohlschläger, Engbert, & Haggard, 2003). Current research shows that the similarity between self- and other generated actions increases with the salience of the action effect (i.e., loudness of beep). Our results are consistent with the view that (1) intentions are attributed to others but not to machines, (2) we attribute intentions to ourselves in the same way as we do to others, and (3) that (2) is only true or possible if the content of the intention can be shared between Me and You, that is, if the intention is about a distal effect.

The studies on brain systems underlying action identification were conducted in cooperation with Tilo Kircher, Dirk Leube and Frank Stottmeister at the Dept. of Psychiatry, University of Tübingen, Germany.

The studies on temporal awareness of self- and other-generated actions were conducted in collaboration with Patrick Haggard, University College, London, UK.

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Knoblich, G., & Flach, R. (2003). Action identity: Evidence from self-recognition, prediction, and coordination. *Consciousness and Cognition, 12(4),* 620-632.

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Knoblich, G., & Prinz, W. (2001). Recognition of self-generated actions from kinematic displays of drawing. *Journal of Experimental Psychology: Human Perception & Performance, 27(2),* 456-465.

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Leube, D., Knoblich, G., Erb, M., Grodd, W., Bartels, M., & Kircher, T. T. J. (in press). The neural correlates of perceiving one's own movements. *Neuroimage, 20(4),* 2084-2090.

Leube, D., Knoblich, G., Erb, M., & Kircher, T. T. J. (2003). Observing one's hand become anarchic: An fMRI study of action identification. *Consciousness and Cognition, 12(4),* 597-608.

Repp, B. H., & Knoblich, G. (in press). Perceiving action identity: How pianists recognize their own performances. *Psychological Science.*

Wohlschläger, A., Engbert, K., & Haggard, P. (2003). Intentionality as a constituting condition for the own self – and other selves. *Consciousness and Cognition, 12(4),* 708-716.

Wohlschläger, A., Haggard, P., Gesierich, B., & Prinz, W. (2003). The perceived onset time of self-and other-generated actions. *Psychological Science, 14(6),* 586-591.

Section 2: Coordinating Actions and Events

Wolfgang Prinz, Natalie Sebanz, Andreas Wohlschläger, Günther Knoblich
Matthias Weigelt, Gisa Aschersleben, Martina Rieger, Michael Öllinger

Introduction

In order to act successfully, the coordination of actions with events that occur in the environment is often crucial. Separate-coding accounts need to postulate informational transformations to explain how coordination between the action system and the perceptual system is achieved. Because timing is often critical, for the coordination of actions and events the complexity of such transformations would pose an enormous problem for the cognitive apparatus. The common-coding account tells a much simpler story.

Event representations that are common to perception and action render transformations between perceptual and motor information obsolete (at least on the level of functional analysis). As a consequence, they provide an ideal medium for the coordination of action-related and environmental information. This implies the opportunity to rapidly integrate changes in the perceptual input, which result from earlier actions, with the expected results of future actions.

Projects

The common-coding approach emphasizes the role of privileged relations between perception and action – in other words, relations in which either perceived features specify the characteristics of potential actions or in which characteristics of a prepared or executed action correspond with the features of a stimulus to be perceived. The project **Temporal Coordination of Actions and Events** addresses the issue of the temporal coordination of actions with events. Based on the well-known effect that in a synchronization task actions precede the events to be synchronized, the project investigates the role of sensory action effects on the temporal control of actions. From the common-coding perspective, actions are represented and controlled by their (anticipated) action effects. Thus, the influence of manipulations of sensory action effects on the (temporal) control of actions is directly predicted by this approach.

The assumption that common codes provide a medium for the rapid integration of different types of perceptual and action-related information also has implications for bimanual coupling. Whereas it is widely believed that constraints for the production of bimanual movements arise exclusively in the motor system, the assumption of common codes assigns an important role to the perception of events that result from these movements (i.e., the action effects). The project **Bimanual Coordination** seeks to determine whether this perspective is supported by empirical results.

Human motor behavior is remarkably accurate even though many everyday skills require that people flexibly adjust their actions to some type of transformation between an motor action and its consequences in extracorporal space. This is the case when one uses a tool – the same action can have different effects in extracorporal space depending on the tool used. The common-coding approach predicts that the simplicity of action control is achieved by planning the behavior of the tool in extracorporal space. This assumption is investigated in the project **Tool Transformation**.

For imitation, the common-coding approach suggests that movements observed in another person are not imitated as a whole. Rather, different events the person produces in the environment should carry more or less information about this person's action plan. In addition, the imitator's common-coding system should be more strongly activated by goal-related aspects of an action. The project **Imitation** investigates whether this creates a tendency to imitate goals and not movements.

Another important question the common-coding account speaks to is the integration of one's own and others' actions during joint action. The assumption that both are represented as anticipated events suggests that if one shares a task with another person, this person's task and actions will be represented in the same way as one's own. This should even be true for situations in which the other's actions are completely irrelevant for one's own. Furthermore, joint action often requires real-time coordination of actions across individuals, e.g. when rowing a canoe together. In this case, common codes might be used to acquire joint coordination strategies. Both issues are addressed in the project **Joint Action**.

2.1. Temporal Coordination of Actions and Events

Gisa Aschersleben
Avner Caspi
Knut Drewing
Katharina Müller
Bettina Pollok
Prisca Stenneken
Andreas Wohlschläger

Part of the Project Area Manipulating Somatosensory Feedback in Sensorimotor Synchronization *has been conducted in collaboration with Jonathan Cole, Poole Hospital and University of Southampton, UK and Jacques Paillard, CNRS, Centre de Recherche en Neurosciences Cognitives, Marseille, France. This research was supported by the Deutsche Forschungsgemeinschaft (DFG SFB 462 Sensomotorik).*

In the common-coding approach perspective, actions are represented and controlled by their anticipated action effects. Thus, the influence of manipulations of sensory action effects on the temporal control of actions is directly predicted by this approach. In sensorimotor synchronization (see Figures 2.1.1 and 2.1.2), this *effect hypothesis* can be tied to the observation that participants regularly produce an asynchrony between pacing signal and response. To explain why these asynchronies are always negative, in other words, why reactions have to precede the signals for the impression of synchrony to emerge, we have developed models which follow the basic assumption that the synchronization of signals and reactions is based on the timing of the central representations of both events (for overviews, see Aschersleben, 2002; Aschersleben, Drewing, & Stenneken, 2002). Timing of the central representation of the action is then determined by the specific (sensory) effects of the action performed. Thus, manipulations of sensory action effects should have a predictable influence on the temporal control of action. In some parts of the project, this effect hypothesis is tested within the so-called continuation paradigm (see Figure 2.1.2) in which participants initially synchronize their finger movements with a set click, but then carry on tapping without a pacing signal.

Figure 2.1.1: Experimental setup used in the synchronization-continuation paradigm for hand- and foot-tapping tasks.

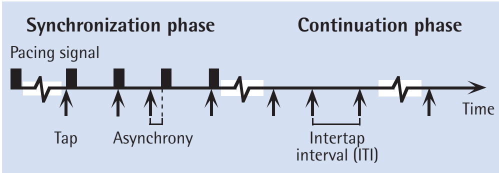

Figure 2.1.2: In the synchronization-continuation paradigm participants initially synchronize their finger movements with a sequence of isochronous clicks. In the continuation task, they then carry on tapping without the pacing signal. The asynchronies between click and tap and the intertap intervals are analyzed as dependent variables.

Manipulating Somatosensory Feedback in Sensorimotor Synchronization

To clarify the role of somatosensory feedback in the temporal control of tapping movements three kinds of manipulations were tested: enhanced, reduced, and eliminated somatosensory feedback. (1) Enhancing somatosensory feedback by instructing participants to tap with large finger amplitudes (leading to an increased tactile and kinesthetic feedback) results in a reduced negative asynchrony (Aschersleben, Gehrke, & Prinz, in press), whereas (2) reducing somatosensory feedback by applying local anesthesia to the tapping finger (i.e. eliminating the tactile component) leads to an increase in negative asynchrony (Aschersleben, Gehrke, & Prinz, 2001). (3) Synchronization performance under conditions with a complete loss of somatosensory feedback can only be studied in deafferented patients. By manipulating the amount of extrinsic feedback (auditory feedback and visual control of movements) we clearly demonstrated the influence of sensory feedback on the timing of actions in two completely deafferented patients (Aschersleben, Stenneken, Cole, & Prinz, 2002; Stenneken, Cole, Paillard, Prinz, & Aschersleben, subm.). Further experiments with one of the deafferented participants requiring him to temporally coordinate hand and foot movements support the interpretation in terms of an internal generation of the movements' sensory consequences (forward modeling; Stenneken, Aschersleben, Cole, & Prinz, 2002).

Neuromagnetic Correlates of Sensorimotor Synchronization

Central processes underlying the performance in a synchronization task were analyzed with magnetoencephalography (MEG). Evoked responses were averaged time-locked to the auditory signal and the tap onset. Tapping of the right hand and the left hand was associated with three tap-related neuromagnetic sources localized in the contralateral primary sensorimotor cor-

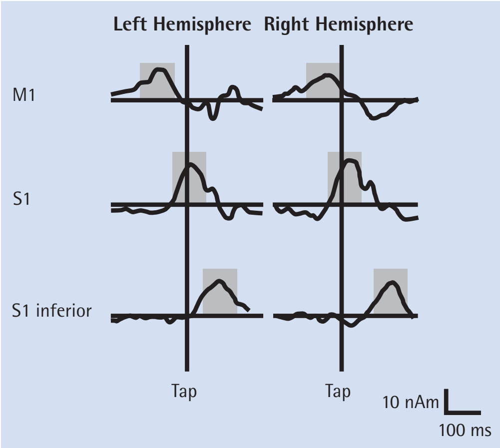

Figure 2.1.3: Grand averages across participants of the six sources time – locked to the tap following bimanual synchronization. Vertical lines depict tap onsets. Grey squares denote peak latencies. During bimanual tapping the same areas are activated in both hemispheres (in M1, S1 and S1 inferior). No significant differences of latencies or amplitudes between sources of left and right hemisphere were found.

tex. While the first source represents the neuromagnetic correlate of the motor command, the second and third one reflect somatosensory feedback due to the finger movement (Müller et al., 2000, *J Cog Neurosci, 12,* 546-55; Pollok, Müller, Aschersleben, Schmitz, Schnitzler, & Prinz, 2003). Moreover, bimanual synchronization was associated with the same three sources in each hemisphere (see Figure 2.1.3). Thus, different to what has been suggested in the literature, dominance of the left motor cortex does not seem to be a fundamental characteristic for bimanual coordination (Pollok, Müller, Aschersleben, Schnitzler, & Prinz, in press). Finally, a study comparing auditory with tactile pacing suggests a specific role of the third source in movement timing. No asynchrony was observed with tactile pacing. Moreover, the localization of the two earlier sources seemed to be modality-independent whereas location of the third source varied with modality. Thus, the central data reveal that modality-specific control units are responsible for temporal precision in sensorimotor synchronization (Müller, Aschersleben, Schmitz, Schnitzler, Freund, & Prinz., subm.).

Bimanual Coupling and Action Effects

In the continuation paradigm (see Figure 2.1.2) within-hand variability of intertap intervals is reduced when participants tap with both hands as compared to single-handed tapping. This bimanual advantage can be attributed to timer variance (according to the Wing-Kristofferson model; Wing & Kristofferson, 1973, *Percept Psychophys, 14,* 5-12), and separate timers for each hand were proposed, of which the outputs are averaged (Helmuth & Ivry, 1996, *JEP:HPP, 22,* 278-93). Alternatively, we suggested that timing is based on sensory movement consequences and the bimanual advantage is due to their enhancement. The amount of sensory effects was manipulated in various experiments (Drewing & Aschersleben, 2003; Drewing, Hennings, & Aschersleben, 2002; Drewing, Stenneken, Cole, Prinz, & Aschersleben, subm., see Figure 2.1.4): (1) Additional auditory action effects reduced timer variability for both uni- and bimanual tapping. (2) Moreover, the bimanual advantage decreased when auditory feedback was removed from taps with the accompanying hand. These results indicate that the sensory movement consequences of both hands are used and integrated in timing. (3) The bimanual advantage decreased when tactile feedback from the left hand's taps was omitted (e.g., by contract-free tapping). (4) Results from a study with the deafferented person IW, who exhibited a pronounced bimanual advantage, indicate that the timing of movements is based on *anticipated* sensory consequences instead of the actual ones. To account for these findings a reformulation of the Wing-Kristofferson model is proposed assuming that the timer provides action goals in terms of anticipated sensory movement consequences.

The Project Area Neuromagnetic Correlates of Sensorimotor Synchronization *has been conducted in collaboration with H.-J. Freund, Alfons Schnitzler and Frank Schmitz, Dept. of Neurology, Heinrich-Heine-University, Düsseldorf. Supported by a special grant from the Max Planck Society (PSF0320).*

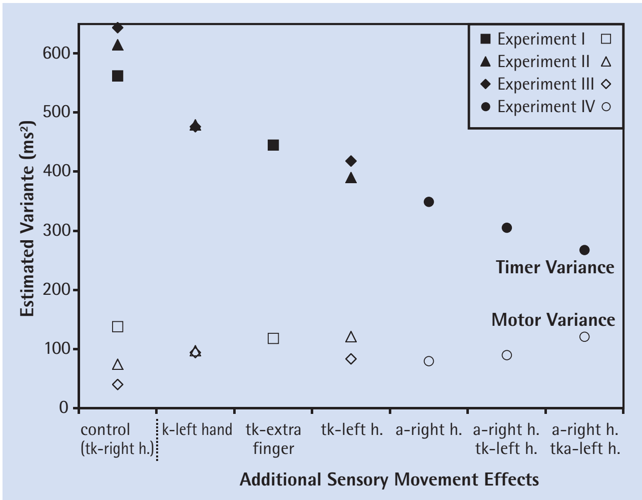

Figure 2.1.4: Mean estimates of right hand's timer (filled symbols) and motor variances (empty symbols) as a function of sensory movement effects. Sensory effects were augmented by additional auditory (a) feedback, or by varying intrinsic tactile (t) or kinesthetic (k) feedback from an additional simultaneously tapping finger of the same or an extra hand (data from four experiments in Drewing, 2001; Drewing & Aschersleben, 2003; Drewing, Henning, & Aschersleben, 2002).

Alternative Approaches in Sensorimotor Synchronization

The Role of Attention in Sensorimotor Synchronization

An alternative account assumes that the asynchrony in tapping owes to higher attention on one modality. The latter is considered to enter with priority, thus the signal from the unattended modality has to physically anticipate the signal from the attended one. Several methods of changing the allocation of attention between the auditory and the tactile modality failed to reduce asynchrony. The only reliable effect was a reduction of the asynchrony with the difficulty to detect a change in the repeated signal. The failure to produce an effect of attention in a series of eight different experiments allows us to conclude that the differential allocation of attention plays no role in explaining the asynchrony in tapping.

Structuring the Interval Reduces Asynchrony

The effect that intervals filled with additional signals have on the asynchrony leads to an alternative approach using the time-perception framework (Wohlschläger & Koch, 2000, in Desain & Windsor (Eds.), *Rhythm perception and production,* 115-127). This account assumes that the asynchrony is a due to a misperception of the time interval between any two successive markers: An empty interval is underestimated, and therefore its (re)production is too short. In contrast, randomly or rhythmically filled intervals lead to a reduction of the asynchrony which actually disappears under certain conditions. Using bimanual tapping, we separated the time-keeper variance from the motor variance. Since the time-keeper variance is linearly related to the length of the time-keeper interval and the time-keeper variance was higher for filled than for empty intervals, we could demonstrate that structuring the interval influences the time-keeper interval, rather than the phase synchronization. A series of further experiments demonstrated that the effect on the time keeper depends on the relative temporal position of additional auditory signals. Signals in the first half of the interval significantly reduce the asynchrony, whereas signals in the second half do not. A simple model based on interval prediction is able to explain most of our data and many of those of other studies: (1) The first signal (auditory signal or tap) within a tolerance zone of the predicted interval triggers the next prediction. Asynchrony thus emerges from motor variance: Only taps that come to early trigger the next prediction. (2) Each interval is predicted with a tolerance proportional to its length. This explains why the asynchrony is proportional to interval length and why structuring a long interval into two or shorter ones leads to reduced asynchrony.

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Drewing, K. (2001). *Die Rolle sensorischer Reafferenzen bei der zeitlichen Steuerung von Handlungen* [A role for sensory reafference in the timing of actions]. Berlin: Logos.

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Drewing, K., Hennings, M., & Aschersleben, G. (2002). The contribution of tactile reafference to temporal regularity during bimanual finger tapping. *Psychological Research, 66(1),* 60-70.

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2.2. Bimanual Coordination

Dirk Kerzel
Günther Knoblich
Franz Mechsner
Wolfgang Prinz
Martina Rieger
Matthias Weigelt

The project investigates the role of action effects and action targets in the coordination of bimanual movements. According to our general working hypothesis, which is derived from the common-coding approach, movements are functionally organized by a representation of their anticipated perceptual effects and target positions.

Periodic Bimanual Movements

In periodic bimanual movements there is a typical tendency towards mirror-symmetry. Traditionally, this symmetry bias has been interpreted as a tendency towards co-activation of homologous muscles. We provide strong evidence that challenges this traditional assumption.

In the classical bimanual finger oscillation paradigm, a person stretches out both index fingers and oscillates them in symmetry or in parallel. With increasing oscillation frequencies, a parallel pattern involuntarily switches into a mirror-symmetrical movement pattern. We varied the original paradigm by putting the hands individually either palm up or palm down. When both palms are up or both are down, the hand position is called "congruous". When one palm is up and the other is down it is called "incongruous". The critical condition is with incongruous hand position. If there is a bias towards co-activation of homologous muscles, the parallel pattern should be more stable than the symmetrical pattern. However, our results showed that, independent of hand position, a symmetrical finger oscillation pattern is always stable whereas parallel oscillations tend to disintegrate and to switch into symmetry. Thus, the symmetry tendency observed in the bimanual finger oscillation paradigm has to be understood as a tendency towards perceptual, spatial symmetry, without regard to processes in the motor system (Mechsner, in press-c; Mechsner, Kerzel, Knoblich, & Prinz, 2001). Converging evidence for these results was obtained with other bimanual oscillation paradigms (Mechsner, Hove, & Weigelt, subm.; Mechsner, Jordan, & Strobl, subm.; Mechsner, Kerzel, Knoblich, & Prinz, 2001; Mechsner & Knoblich, subm.).

Discrete Bimanual Movements

Spatial coupling effects in discrete bimanual reaching movements have traditionally been associated with preparatory processes during motor programming, in which particular movement parameters have to be specified (e.g., amplitude and direction). However, according to the ideomotor approach to voluntary action, target specification, but not parameter specification should be a crucial step in movement planning. In several experiments participants had to move from two starting positions to two target locations. The two target locations necessitated either the same or different a) movement amplitude, or b) movement direction (see Figure 2.2.1). The symbolic stimuli to cue the target locations were arranged such that either equal or unequal movement parameters went together with equal target stimuli (symmetric vs. asymmetric target cue arrangement). Movements were initiated faster to identical target cues, regardless of the underlying movement parameters. Thus, target specification plays a major role in planning bimanual movements.

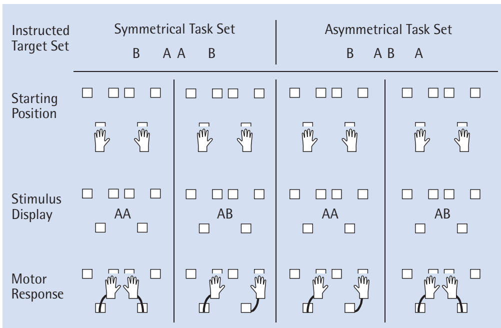

Figure 2.2.1: Experimental setup for the symbolic target cueing task for the parameter direction. As an example, the bimanual movements could be cued by the letters A and B. Depending on whether A means "move inwards" and B "move outwards" or A means "move to the left" and B "move to the right", equal stimuli can go together with equal or unequal movement parameters.

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Mechsner, F. (in press-c). Spontaneous coordination tendencies in bimanual finger adduction and abduction. *The Quarterly Journal of Experimental Psychology. Section A: Human Experimental Psychology.*

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Schack, T., & Mechsner, F. (subm.). *Representation of motor skills in human long-term memory.*

2.3. Tool Transformation

Günther Knoblich
Wolfgang Prinz
Martina Rieger

A popular idea is that the CNS predicts the consequences of our motor commands. Predictions can refer to bodily consequences (e.g., how our arm moves), but are not restricted to them. For instance, predictions about the action of a tool (e.g., a hammer) could be generated as well. This requires flexible mapping between actions and their consequences, because the same action can have different effects in extracorporal space, depending on the tool used. According to common-coding theory and the ideomotor approach to voluntary action, performing voluntary actions involves a representation level that codes distal events. This implies that action production is guided by planning actions in relation to their effects in extracorporal space. For tool use this means that actions are guided by the behavior of the tool. The main focus of this project is twofold – to determine (1) the effect tool behavior in extracorporal space has on the organization of actions, and (2) the limits of action organization with reference to extracorporal space.

Adaptation to Length Transformations

If actions are controlled with reference to extracorporal space, action kinematics should differ with the visual context in which an action occurs. In a paradigm investigating this issue participants repeatedly and continuously made up-and-down strokes on a writing pad. They received feedback of their trace on the screen. After drawing under a base mapping either (a) a change of target position, (b) a change of gain, or (c) both occurred (see Figure 2.3.1). Adaptation to changes occurred with reference to extracorporal space – strokes that required the same action distance were performed with different kinematics depending on the visual context (Rieger, Knoblich & Prinz, subm.).

Transformation of Angle in Circular Action

In another paradigm participants continuously performed, with a crank, circular actions on a writing pad. Their action trace was presented on the screen. In certain areas on the circle a gain change was introduced (reduction or extension of the angle the trace traveled relative to the action). The presented action trace influenced the action even in a condition in which it was completely irrelevant for task performance.

Rhythm Production by Circular Actions

Moreover, we investigated the production of discrete action effects. Participants again performed circular actions on a writing pad. At two points during the action they heard a tone. They were instructed to produce either a difficult or an easy rhythm. Further, rhythms could be produced by circling either evenly or unevenly. In different conditions (synchronization with visual stimulus/ continuation/ free production) the same pattern of results was obtained. When participants had to circle unevenly no differences between conditions were present, but with the even movement participants were better at producing the easy as compared to the difficult rhythm. Also, performance was less variable when the easy rhythm had to be produced.

Rieger, M., Knoblich, G., & Prinz, W. (subm.). *Compensation for and adaptation to changes in the environment.*

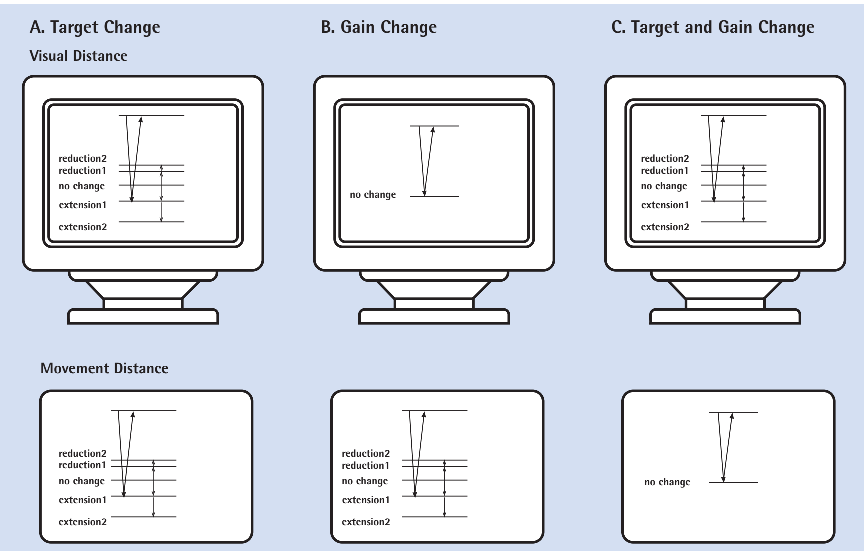

Figure 2.3.1: Illustration of the experimental manipulations relative to a baseline condition. A. Change of target position: The target position is presented at either a reduced or extended amplitude (2 levels each), and the action needs to be reduced or extended correspondingly. B. Change of gain: The visual distance remains the same, but the action needs to be reduced or extended. C. Target and gain change: The visual distance changes, but the required action distance remains the same.

2.4. Imitation

Harold Bekkering
Andreas Wohlschläger

Imitation, or performing an act after perceiving it, guides the behavior of a remarkable range of species at all ages. Imitation also serves an important function in human development offering the acquisition of many skills without the time-consuming process of trial-and-error learning. The common view on how perception and action are mediated in imitation holds that a matching takes place between the perceptual input and existing motor programs in the observer. We, however, have argued that this matching does not take place at the motor level, but rather at the cognitive level of goal specification. (Wohlschläger, Gattis, & Bekkering, 2003; Gattis, Bekkering, & Wohlschläger, 2002; Bekkering & Wohlschläger 2002). In addition, we recently showed that the human homologue of the monkey's mirror-neuron area, an area that is known to contain cells that respond to both the execution and observation of goal-directed actions, is more active during the imitation of goal-directed actions than during the imitation of actions without an explicit goal (Wohlschläger & Bekkering, 2002; Koski et al., 2002).

More recently, we have tried to determine the nature of the goal hierarchy in more detail. In a series of experiments, adult participants had to imitate a pen-and-cup action. The action modeled consisted of several components: There were two different objects, two possible locations, two treatments of what to do with the pen and the cup, two effectors (left or right arm), and two movements (clockwise or anticlockwise; see Figure 2.4.1). As predicted by the goal-directed theory of imitation, the category of errors observed most frequently was the type of movements performed. The second and third most frequent types of errors were the effector chosen and the location. Almost no errors occurred for treatment, and the best-imitated component was the object. Taken together, these observations indicate that imitation is not about copying movements. Rather, it is the goal of the action observed that we imitate. The organization of these goals seems to be very functional, that is, the ends of an action are more important than the means (Wohlschläger, Gattis, & Bekkering, 2003).

Since imitation is thought to play an important role in social and communicative skills, we also drew on the goal-directed theory to investigate imitation performance in a group that is known to have deficits in these skills: adult Asperger and high-functioning autistic participants. We were able to demonstrate that these participants also follow the functionality principle, for example, by ignoring the effector but choosing the correct object. However, whereas normal controls profit from a mirror-image situation by showing less errors in the imitation of aspects of the movement, Asperger and high-functioning autistic participants do not (Avikainen, Wohlschläger, Liuhanen, Häninnen, & Hari, 2003).

In another recent study we analyzed the imitative learning in 14-month-old children. It was demonstrated that while infants of this age can imitate a novel means modeled to them, they do so only if the action is seen by them as the most rational alternative to the goal available within the constraints of the situation, thus again supporting a "rational imitation" account over current "imitative learning" accounts (Gergely, Bekkering, & Király, 2002).

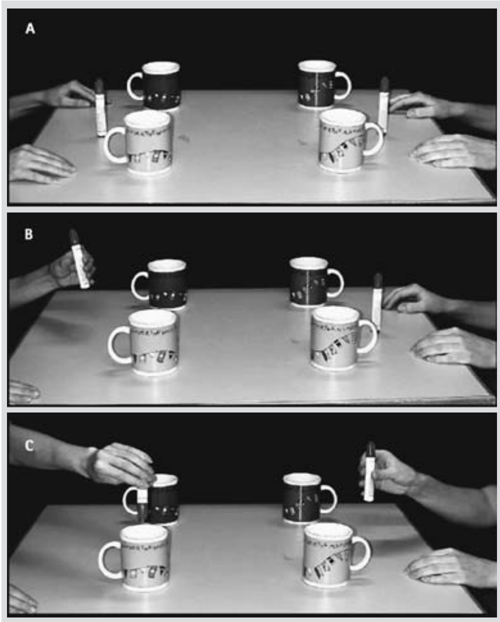

Figure 2.4.1: Example of the pen-and-cup imitation task. The participant sits opposite to the experimenter at a table, each of them has a blue cup, a green cup, and a pen in front of them. The participant imitates the experimenter's movements as simultaneously and accurately as possible.

In collaboration with Ildiko Király and György Gergely, Hungarian Academy of Sciences, Budapest; Merideth Gattis, School of Psychology, Cardiff University; Harold Bekkering, Nijmegen Institute for Cognition and Information, University of Nijmegen; Lisa Koski, Roger P. Woods, Marie-Charlotte Dubeau, John C. Mazziotta, Marco Iacoboni, UCLA School of Medicine; Sari Avikainen, Sasu Liuhanen, Riitta Hari, Brain Research Unit, Helsinki University of Technology; Ritva Hänninen, Dept. of Neurology, Central Hospital of Central Finland.

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2.5. Joint Action

Günther Knoblich
Wolfgang Prinz
Natalie Sebanz

The study on autistic individuals was conducted in cooperation with Luitgard Stumpf at MAut (Integration Center for Humans with Autism).

Joint Representation of Tasks and Actions

In many social situations we find ourselves doing what others do. We yawn when the person riding beside us on the bus is yawning, we cross our legs when our conversation partner crosses her legs, and in the pub we drink from our glass when our friend also takes a sip. These forms of behavior matching can be explained in terms of ideomotor theory, which predicts that observing others' actions activates representational structures that are also involved in one's own control of these actions. Previous research has confirmed that observing others' actions can affect the individual performance of the same actions. We developed a paradigm to investigate whether and how complementary actions at the disposal of a co-actor are represented and influence one's own actions. Assuming that representations of one's own and others' actions share a common representational domain, one can predict that observing or knowing about another person's actions may lead to similar effects as performing these actions oneself.

This assumption was tested in a series of experiments (Sebanz, Knoblich, & Prinz, 2003). We devised a variant of a spatial compatibility task (Simon task) and compared performance of individual participants in three conditions. In one condition, participants performed the task on their own. They observed pictures of a hand pointing to the right or left. On the index finger of the hand was a red or green ring (cf. Figure 2.5.1). Pointing direction of the finger was irrelevant for the task. Participants were asked to respond to one color with a left button press and to the other with a right button press. We replicated the well-established finding that responses are faster when the irrelevant spatial dimension corresponds with the response indicated by the color stimulus and slower when there is no such correspondence. For example, when the instruction was to respond to red with a left button press and to green with a right button press, participants responded faster on "red trials" when the finger pointed left than when it pointed right, and on "green trials" when the finger pointed right than when it pointed left.

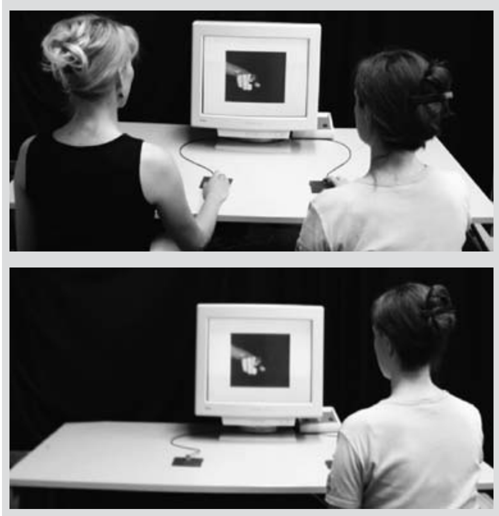

Figure 2.5.1: Joint and individual condition. The same go-nogo task is carried out in both conditions (respond to a certain ring color and not to respond to the other).

In the critical group condition, the two action alternatives were distributed among two co-actors, so that each participant responded to only one of the two colors. Thus, the task for each participant was no longer a two-choice reaction-time task, but a go-nogo task. If observing a co-actor's actions activates representational structures involved in one's own planning and control of these actions, then observing (or knowing about) the other's action alternative may lead to a similar effect as having the other action alternative at one's own disposal. Thus, there should be a spatial compatibility effect in the group condition, just as in the condition where single participants took care of both action alternatives. In contrast, when the identical go-nogo task is performed alone and no one takes care of the other action alternative (individual condition), there should be no compatibility effect. Figure 2.5.1 shows the setting (a) in the group and (b) the individual condition. Results confirmed the predictions derived from ideomotor theory and the notion of common coding. In the group, a compatibility effect was present. Responses were faster on compatible trials, where the finger pointed at the person to respond, and slower on incompatible trials, where the finger pointed at the person not to respond. No compatibility effect was observed in the individual condition. Control experiments confirmed that the joint compatibility effect only emerges when the task is shared and not merely in the presence of another person. It is crucial to know the other's task, whereas continuous feedback about the other's actions is not necessary.

In a further experiment, conducted in cooperation with the junior research group "Cognitive Psychophysiology of Action", we recorded event-related potentials (ERPs) while participants performed the task described above (Sebanz, Knoblich, Prinz, & Wascher, subm.). In the joint condition, ERPs were recorded simultaneously in both participants of a pair. In line with our assumptions, ERP components related to action control were more pronounced when the same task was performed jointly than when it was performed alone.

In addition, we conducted a neuropsychological study on autistic individuals using the joint compatibility paradigm (Sebanz, Knoblich, Stumpf, & Prinz, in press). Autistic individuals are known to have problems with attributing mental states to others. It has been suggested that the ability to represent goal-directed actions is a pre-cursor to mentalizing. Thus, one may expect that individuals with autism have a deficit in representing others' actions and do not show the joint compatibility effect. However, our study revealed the same data pattern for autistic individuals as for healthy controls. Thus, it is likely that the joint compatibility effect arises on a processing level that is different from the one that supports mental state attribution.

We have also started to look at further variants of the joint compatibility task. In one of them, one participant carries out the color task (as in the original task), but the other participant responds to the pointing direction (Sebanz, Knoblich, & Prinz, in press). In this condition, the effect observed in the person responding to color was significantly larger than in the standard setting. Thus, the relevance of the pointing response for the partner increased the size of the joint compatibility effect in the person who responded to color. This result can hardly be explained without the assumption that a co-actor's specific task is represented during joint action, even when it is irrelevant for one's own task.

Taken together, the results provide evidence that when a task is shared among two co-actors, each actor represents the other's task and integrates it in his/her action planning, even when the co-actors could completely ignore each other's tasks. We assume that the joint compatibility effect arises on a level at which one's own and others' actions are represented in a functionally equivalent way.

Perception and Performance During Coordinated Action

When groups of individuals work toward a common goal such as paddling a canoe, each group member must externalize his/her intentions, perceive the externalized intentions of the others, and plan his/her actions in relation to those perceived intentions in order to avoid action conflicts (Knoblich & Jordan, 2002). We assume that common event codes are central for the coordination of actions across individuals, because they provide a medium for rapidly dealing with the actual and anticipated outcomes of self- and other-generated actions. This assumption was supported by two studies (Jordan & Knoblich, in press; Knoblich & Jordan, 2003). Both studies used a simple tracking task in which the same action conflict had to be resolved either by one individual or by two individuals engaging in joint action. The results show that joint action profoundly influences performance and perception. They are also consistent with our claim that the integration of first and third-person information occurs on a level of common event representations.

The research on perception and performance during coordinated action was performed in cooperation with Scott Jordan, Illinois State University, Normal, IL, USA.

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Section 3: Interference Between Actions and Events

Jochen Müsseler, Marc Grosjean, Iring Koch, Wolfgang Prinz
Gisa Aschersleben, Simone Bosbach, Chiara Begliomini, Stefanie Schuch

Introduction

Introspectively, perception and action seem to fulfill different cognitive functions: Perception processes pick up and analyze events in the environment (mainly by afferent mechanisms), whereas action processes are generated internally and may produce and influence events in the environment (mainly by efferent mechanisms). Although perception and action processes are highly interactive under most ecological conditions (e.g., in sensorimotor tasks like pointing or grasping), they seem to operate relatively independently from one another.

On the other hand, there are also observations from everyday life which give reason to doubt this independence. A well-known example is the driver who misses a stop sign when engaged in conversation. Obviously, the act of conversation prevented the driver from making an adequate response. One possibility is that the driver failed to prepare the appropriate action. Another possibility is that the act of conversation interfered with what was perceived.

Research Questions

This section examines such interferences between perception and action. The theoretical starting point is the common-coding assumption (or also: event-coding account) which holds that action planning is controlled by representational structures that can also serve to represent the contents of perceptual events (see above; Hommel, Müsseler, Aschersleben, & Prinz, 2001). In other words, action planning and perceptual encoding are assumed to operate on partially overlapping representations and are, therefore, prone to interfere with each other.

Two approaches are used to analyze these interferences. The first investigates in an unspecific manner (i.e., with no feature overlap between response and stimulus) whether and how the processing of a response task can exert an influence on the processing of a perceptual task and vice versa. The second approach examines specific relations between perception and action, which exist in situations where either perceived features specify the characteristics of potential actions (stimulus-response compatibility) or characteristics of a prepared or executed action correspond with the features of a stimulus to be perceived (response-stimulus compatibility). For example, when stimulus and response correspond spatially (e.g., a right-hand reaction given to a right-hand stimulus), better performance is observed than when they do not correspond (e.g., a right-hand reaction given to a left-hand stimulus). However, spatial properties of stimuli also have an impact on the planning of actions when they are completely irrelevant to the task at hand. Even when instructed to react to nonspatial stimulus properties (e.g., with a right-hand reaction when an X is displayed), participants perform better when the stimulus appears on the same side as the response.

Projects

Our projects employ various versions of these interference paradigms. All of them involve dual-task situations in which observers are confronted with two functionally unrelated tasks. In the projects concerned with **Effects of Action on Perception**, the main research question is whether processes of action planning are able to exert an influence on perceptual processes and, if so, how. This question was addressed by having participants perform an action while simultaneously perceiving a stimulus. Correspondingly, the main dependent variable in these tasks is the probability of correct visual discrimination, that is, how good participants are in identifying a stimulus.

Action planning and perceptual processing can affect each other in functionally unrelated tasks.

In the studies dealing with **Effects of Perception on Action**, the opposite question is addressed, that is, whether and how perceptual processing can exert an influence on action planning. The tasks were similar to those used above, however, the main dependent variable was now reaction time, that is, how fast people are able to respond to the presentation of stimulus. These projects focus on cross-task compatibility effects.

Finally, in the studies concerned with the **Concurrent Production and Perception of Events**, the same questions as in the first two sets of projects were addressed. However, instead of using briefly presented stimuli and button-press responses, more dynamic perceptual and motor events were employed. Namely, various forms of light-point trajectories served as stimuli and drawing movements were used as responses. Performance in these tasks was assessed by analyzing the kinematics of the produced movements.

Section 3: Interference Between Actions and Events

3.1. Effects of Action on Perception

Jochen Müsseler
Peter Wühr

This research was partially supported by a grant from the Deutsche Forschungsgemeinschaft (Mu 1298/2). Part of the project has been conducted in collaboration with Claudia Danielmeier, Stefan Zysset and Yves von Cramon (all Max Planck Institute for Neuropsychological Research, Leipzig).

Usually, approaches to human information processing examine and attempt to characterize those processes that transform sensory input signals into overt reaction. The present subprojects address the opposite question, namely whether and how processes of action control influence perceptual processes. The method of choice employs dual-task paradigms, in which participants plan or perform an action while simultaneously perceiving and recognizing stimuli.

Motor task 1: cue S1 ⟶ response R1
Identification task 2: masked S2 ⟶ judgment R2
⟶ t

The basic design is as follows: When a reaction *R1* is performed in response to a cue *S1*, a masked stimulus *S2* is presented. The framework provided by the event-coding account (Hommel, Müsseler, Aschersleben, & Prinz, 2001; cf. also Wühr, Knoblich, & Müsseler, subm.) predicts that simultaneous access to shared codes should reveal elementary interactions; for example, selection and action-planning processes of *R1* should influence perceptual identification of *S2*! Thus, the critical empirical question was whether the identification of *S2* depends on the execution of *R1* and/or the relationship between *R2* and *S1*.

Action-Induced Blindness and Action-Effect Blindness

A typical finding in such dual-task experiments was that visual identification of *S2* was impaired the more the two tasks overlap in time (see also, e.g., Müsseler & Wühr, 2002). In other words, visual encoding was hampered when another task was planned and executed in parallel. In one experiment, the motor task consisted of a GO-NOGO task to examine the specific influence of the action-planning processes on *S2* identification. In GO trials, observers responded with a keypress to particular stimuli while in NOGO trials other stimuli indicated to withhold a response. We hypothesized that the additional demands necessary to plan and execute the keypress additionally impairs the identification of *S2*. This was indeed the case (*action-induced blindness AIB*, cf. Figure 3.1.1; Müsseler & Wühr, 2002; Wühr & Müsseler; 2002; cf. also Jolicœur, 1999, *JEP: HPP, 25*, 596-616).

Another important finding from an event-coding point of view was that observers were less able to identify response-compatible *S2* (e.g., left keypress, left-pointing arrow) as compared to response-incompatible *S2* (e.g., left keypress, right-pointing arrow; *action-effect blindness AEB;* Müsseler, Steininger, & Wühr, 2001; Wühr & Müsseler, 2001, 2002). This result resembled previous findings in our lab (e.g., Müsseler & Hommel, 1997, *Psych Bull & Rev, 4*, 125-29).

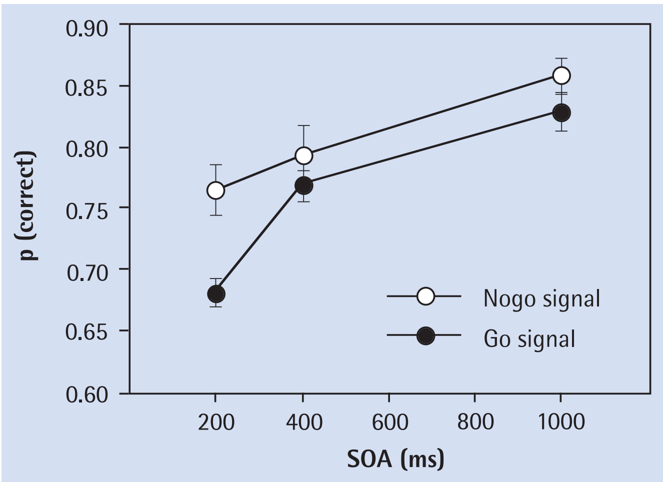

Figure 3.1.1: Mean proportion of correct identifications of S2 in NOGO and GO trials. The x-axis depicts the stimulus-onset asynchrony (SOA) between the presentation of S1 and S2. Results showed that identification of S2 was impaired the more the two tasks overlap in time (i.e., with small SOAs). Identification performance was additionally decreased in GO trials.

Action-Induced Blindness in an Event-Related fMRI Study

In an event-related fMRI study we further investigated the influence of motor components on visual encoding in the first task. Again, an identification task was combined with the GO-NOGO task. Perceptually identical trials with and without a concurrently performed motor response were contrasted to demonstrate the impact of action on visual encoding. Behavioral results showed impaired visual identification in GO trials as compared to NOGO trials. This behavioral impairment was reflected in decreased activation in the visual area V3A and in the right cuneus in GO trials, most pronounced with short stimulus-onset asynchronies (SOAs). Thus, we observed effects in V3A according to which the planning of an action modifies effects in brain areas concerned with visual encoding (cf. Figure 3.1.2; Danielmeier, Zysset, Müsseler, & von Cramon, subm.).

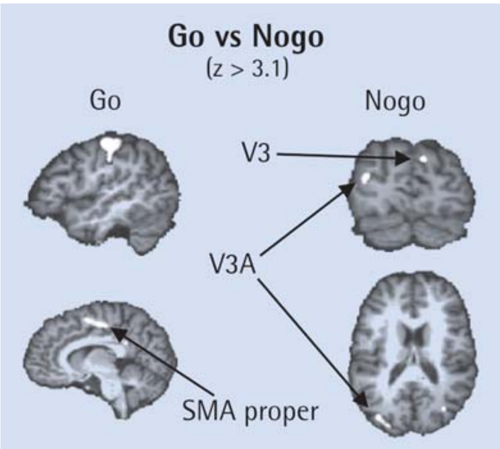

Figure 3.1.2: Averaged contrast images of the GO-NOGO comparisons mapped onto a standard brain. Blobs on the left indicate stronger activation in NOGO trials than in GO trials; the opposite is true for blobs on the right. Results indicated modulations in the visual areas V3A and the medial V3, when motor areas are activated by another task which is performed concurrently.

Action-Induced Blindness with Lateralized Stimuli and Responses

In another series of experiments we examined correspondence effects with lateralized stimuli and responses. Participants responded to tones with a left- or right-hand keypress and while doing this they identified stimuli presented in the left or right visual field. Again, the main finding was that identification performance decreased with the temporal overlap between the tasks. This decrease was observed with both an ipsilateral and contralateral keypress. Furthermore, whether the keypress task was performed with uncrossed or crossed hands did not affect the results. Instead, it seemed to be the keypress location that tended to affect identification performance. We discussed this finding in terms of an action-centered attentional account (Müsseler, Wühr, Danielmeier, & Zysset, subm.).

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3.2. Effects of Perception on Action

Chiara Begliomini
Simone Bosbach
Iring Koch
Jochen Müsseler
Wolfgang Prinz
Stefanie Schuch
Peter Wühr

In the experiments described in the previous section, responses were combined with identification tasks to examine whether action planning and/or execution can exert an influence on perceptual encoding. In the projects described in this section, we examine cross-task effects of perception on action. The resulting dual task is similar to the well-known paradigm of the psychological refractory period (PRP): When two speeded tasks are performed in close succession, performance on the second task is impaired. Recently, an impairment has also been observed when the first task required only the visual encoding of a stimulus (Jolicoeur & Dell'Acqua, 1998, *Cogn Psychol, 36, 138-202*). This finding was the starting point of the present projects.

Process Interference in a Response-Cueing Paradigm

In a series of experiments, Koch and Prinz (2002, subm.) explored interactions between visual encoding processes and action planning and execution. The authors varied spatial cross-task compatibility (CTC) in a response-cueing paradigm in which they used a stimulus movement for later report in a perceptual task and a finger movement as response in a logically independent reaction task. The direction of the target-stimulus' movement and of the to-be-executed speeded response could be either the same (compatible) or different (incompatible).

For instance, in one experiment, Koch and Prinz (2002, Experiment 3) varied the interval between onset of the perceptual target and of the response go-signal (target-go interval, TGI). In addition, in 25% of the trials, participants were informed prior to the start of the trial that they could ignore the visual target for the perceptual task (no-report trials). Findings are shown in Figure 3.2.1. First, strongly increased RTs with short TGI were found indicating dual-task process interference, suggesting a capacity-limited encoding (or "consolidation") process into short-term memory. Second, this interference was reduced in the no-report condition in general and in the short TGI condition in particular. This suggests that interference in the report condition was actually due to visual encoding processes and not to temporal information conveyed by the target onset, because this information was the same in report and no-report conditions.

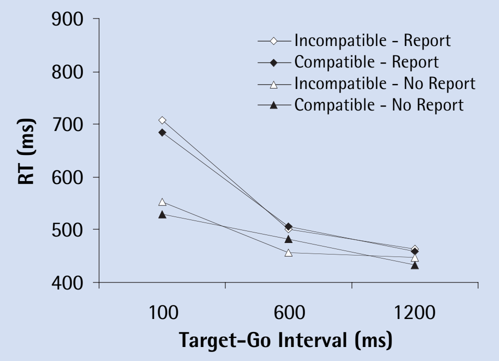

Figure 3.2.1: Findings of Experiment 3 of Koch and Prinz (2002). Reaction times (RTs) to go-signal as a function of compatibility between direction of perceptual target movement and direction of manual response, interstimulus intervals (ISIs) between target and go-signal, and of the necessity to report the target or not.

Also, RTs were shorter in compatible trials than in incompatible trials, indicating a cross-task compatibility (CTC) effect due to code overlap between tasks. Moreover, this cross-task compatibility was also present in no-report trials, suggesting that stimulus-movement direction is automatically encoded even if retaining this information for later report is not necessary. This presumably automatic coding appears to depend on encoding intentions. A manipulation of the encoding instruction can reverse the direction of the CTC effect (Koch & Prinz, subm.), suggesting that the primary basis for the CTC effect is overlap on the level of response codes.

Recently, we extended the exploration of CTC effects to choice-RT paradigms, in which the speeded response was not cued prior to presentation of the visual target but rather by a reaction stimulus (high vs. low tone) occurring after the perceptual target (Azuma, Prinz, & Koch, in press; Koch, Metin & Schuch, 2003). Here, the authors generally found a similar pattern of effects, indicating that the underlying processes can be generalized to different experimental paradigms. It was found that the CTC effect in no-report trials not only occurs when the nature of the trial (report vs. no report) was cued immediately prior to a trial but also when the encoding instruction pertained to whole blocks of trials (Azuma et al., in press). This finding suggests that encoding intentions persist for quite a while even when participants are explicitly told to ignore the secondary task stimulus. Further experiments showed that the pattern of CTC effects and of dual-task process interference is not affected by manipulations of temporal certainty, suggesting that these effects are due to encoding constraints rather than to processing strategies (Koch et al., 2003).

In a current collaboration project, we (Iring Koch and Raffaella Rumiati, Trieste, Italy) explore whether similar dual-task effects can be obtained when the stimuli for the perceptual task are pictures of real-life objects with graspable features (e.g., a mug with a handle). Preliminary data suggest that such object features can indeed prime actions in dual-task contexts. A further collaboration project (Iring Koch and Pierre Jolicoeur, Montreal) investigates whether coding in the up-down direction can produce "orthogonal" CTC effects, which would further broaden the empirical basis for theorizing about the role of code interactions in dual tasks. In general, we interpret the CTC effect as resulting from overlap of code activation across tasks, whereas process interference seems to occur to prevent temporal overlap on the level of perceptual encoding and response retrieval processes.

The Effects of Irrelevant Locations: Cross-Task Simon Effects

Importantly, whereas the stimulus for the perceptual task was irrelevant for the RT task, it was still a relevant stimulus, which had to be attended to in the perceptual task. In another new project, we (Chiara Begliomini and Iring Koch) examine the role of spatial-location information on dual-task performance when this information is irrelevant for both tasks, producing a variant of a "Simon" effect across tasks. This project is also meant to further disentangle the contributions of S-R compatibility and R-R compatibility across tasks (cf. Koch & Prinz, subm.).

In a recent series of experiments we examined correspondence effects between a keypress task and an identification task. Participants responded to tones with a left- or right-hand keypress and while doing this they identified neutral targets with regard to the left/right dimension, but that were presented in the left or right visual field. Especially at short SOAs, responses were faster and less prone to error, when the irrelevant target location corresponded with the keypress than when it did not (cross-task Simon effect). Thus, findings indicated an automatic activation of location even when it is irrelevant for both tasks (Müsseler, Koch, & Wühr, subm.).

The Influence of Visual Motion Perception on Action Control

Examination of previous methods and results from an own series of experiments (Bosbach, Prinz, & Kerzel, subm.) reveal that evidence for direct links between motion perception and action may be explained by relative

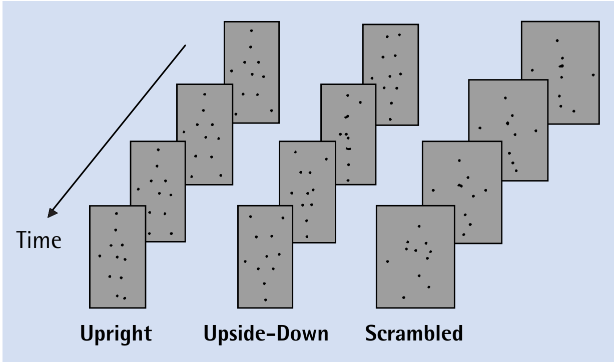

Figure 3.2.2: Johansson's (1973, Percept & Psychophys, 14, *201-211) point-light walker display: 11 dots constituted a human figure seen upright (left and right panels) or upside down (central panel). In Exp. 4 the coherent walkers (left and central panel) were used. In Exp. 5, a few dots of the walker's figure were spatially transposed to destroy the coherent spatial relations among the dots (right panel; cf. Bertenthal & Pinto, 1994,* Psychol Sci, 5, *221-225). The scrambling procedure eliminated possible directional cues available in the global shape of the (static) figure.*

position coding. To clarify whether motion information per se has a separable influence on action control as well, we investigated whether irrelevant direction of motion of stationary moving objects would affect manual left-right responses (i.e., reveal a motion-based Simon effect; Bosbach, Prinz, & Kerzel, in press). In Experiments 1 and 2 significant motion-based Simon effects were obtained for sine-wave gratings moving in a stationary Gaussian window. In Experiment 3 we replicated this effect with random-dot patterns, thus excluding that the perceived direction of motion was based on the displacement of single elements. In Experiments 4 and 5 we studied motion-based correspondence effects to point-light figures that walked in place – displays requiring high-level analysis of global shape and local motion. Motion-based Simon effects occurred when the displays could be interpreted as an upright human walker (cf. Figure 3.2.2), showing that a high-level representation of motion direction mediated the effects. In sum, these experiments successfully establish links between high-level motion perception and action.

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Bosbach, S., Prinz, W., & Kerzel, D. (in press). A Simon-effect with stationary moving stimuli. *Journal of Experimental Psychology: Human Perception and Performance.*

Bosbach, S., Prinz, W., & Kerzel, D. (subm.). *Is direction position? Position- and direction-based compatibility effects in tasks with moving stimuli.*

Koch, I., Metin, B., & Schuch, S. (2003). The role of temporal uncertainty for process interference an code overlap in perception-action dual tasks. *Psychological Research, 67,* 244-252.

Koch, I., & Prinz, W. (2002). Process interference and code overlap in dual-task performance. *Journal of Experimental Psychology: Human Perception & Performance, 28(1),* 192-201.

Koch, I., & Prinz, W. (subm.). *Response preparation and code overlap in dual tasks.*

Müsseler, J., Koch, I., & Wühr, P. (subm.). *Compatibility effects with irrelevant locations in dual tasks: A cross-task Simon effect.*

3.3. Concurrent Production and Perception of Events

Gisa Aschersleben
Marc Grosjean
Wolfgang Prinz
Anna Schubö

Many everyday activities involve performing an action while simultaneously encoding one or more perceptual events. The experiments described in this subsection employed a new task introduced by Schubö, Aschersleben, and Prinz (2001) in order to study how perception and action interact in such situations.

The Serial Overlapping Response Task (SORT)

In contrast to traditional stimulus-response (S-R) compatibility tasks in which the interactions of interest arise from feature overlap *within* S-R assignments, SORT was developed to investigate interactions that arise from overlap *across* assignments (i.e., when the S and R for a trial are not assigned to each other). On a given trial, *n*, the currently presented S_n specified the required R_{n+1} for the subsequent trial, whereas the currently required R_n was specified by the S_{n-1} presented on the previous trial (see Figure 3.3.1). SORT also involved more dynamic stimuli and responses than those usually encountered in the S-R compatibility literature. Stimuli consisted of light-point displays depicting sinusoidal trajectories of small, medium, or large amplitudes; responses consisted of drawing, on a graphics tablet, sinusoidal trajectories of the same amplitudes without receiving visual feedback. Thus, participants were required to perform a previously specified action while simultaneously encoding a functionally unrelated but feature-overlapping perceptual event.

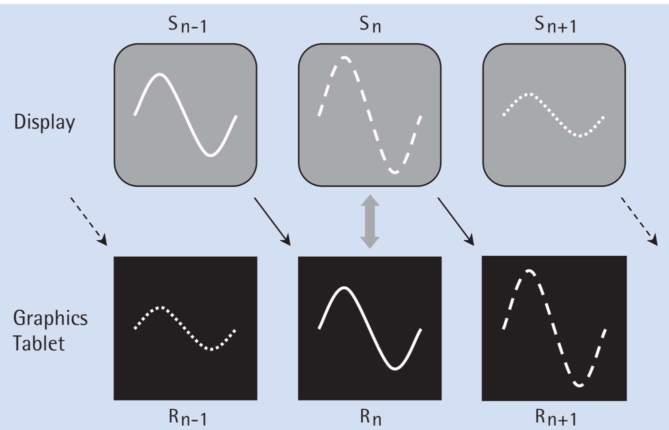

Figure 3.3.1: A schematic of the trial events in the serial overlapping response task (SORT).

A Contrast Effect

As alluded to above, the question of interest in SORT was whether the perception of S_n would specifically interact with the execution of R_n and vice versa. Results revealed evidence for both types of interaction. When participants were required to produce a medium-amplitude trajectory, watching a small-amplitude trajectory led to an increase in movement amplitude, whereas watching a large-amplitude trajectory led to a decrease in movement amplitude (Schubö et al., 2001). This pattern of results was attributed to an influence of perception on action (i.e., an S-R effect).

A similar contrast-like pattern was obtained when considering the impact of action on perception. When participants were required to produce a medium-amplitude trajectory (having watched a medium-amplitude trajectory on the previous trial), there was an increase in movement amplitude when participants had produced a small-amplitude trajectory on the previous trial, whereas there was a decrease in movement amplitude when participants had been required to produce a large-amplitude trajectory on the previous trial (Schubö et al., 2001). The attribution of this latter effect to an influence of action on perception (i.e., an R-S effect) relied on the assumption that the movement produced on a given trial not only reflects the influence of the simultaneously perceived stimulus, but also the manner in which the perception of the stimulus on the previous trial was influenced by the concurrently produced response.

Taken together, these results provide evidence for a new form of specific perception-action interaction that can be characterized as a mutual contrast effect. Schubö et al. (2001) accounted for this effect by invoking a code-modification mechanism that serves to increase the distinctiveness of the codes underlying feature-overlapping events, so that the corresponding perceptual and motor activities can be carried out with a minimal amount of interference. As a consequence, however, what is perceived has a suppressing effect on what is concurrently produced and vice versa.

An Assimilation Effect

To further elucidate the mechanisms underlying the R-S component of the contrast effect, Schubö, Prinz, and Aschersleben (in press) varied the inter-trial-interval in SORT. Replicating their earlier findings, a contrast effect

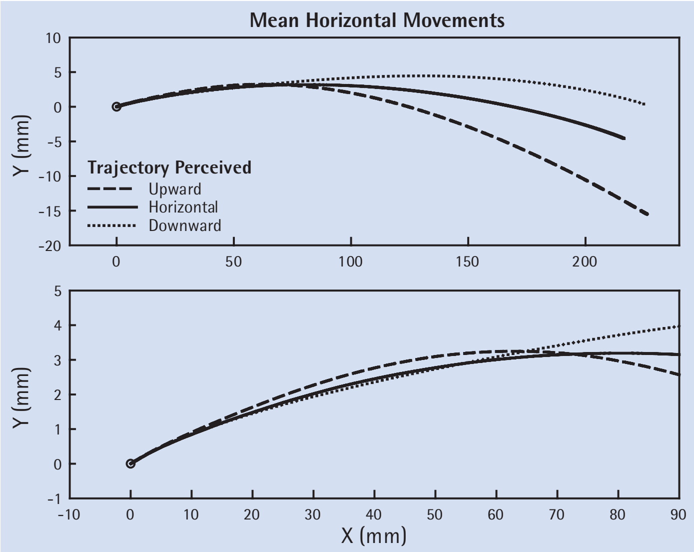

Figure 3.3.2: Top panel: *Mean horizontal movement trajectories as a function of the trajectory perceived on the concurrent trial.* Bottom panel: *The initial portion of the same movement trajectories.*

was obtained when the interval was short (~2 s). When it was long (~8 s), however, evidence of an assimilation effect was found, that is, the effect was reversed. Consistent with what was observed with short intervals, Schubö et al. proposed that contrast arises in perception during and shortly after the concurrent perception and production of events because of the above-mentioned code-modification mechanism. However, consistent with what was observed with long intervals, once the codes underlying these events no longer have to be kept separate from each other, assimilation emerges in memory because of a tendency for those codes to fuse with one another.

Further Explorations Using SORT

In a new series of experiments, we investigated three aspects of the S-R component of the contrast effect: its generality, time course, and its dependence on feature overlap between relevant S-R dimensions.

The Generality of the Contrast Effect

To establish whether the contrast effect could also be observed for other S-R dimensions, the sinusoidal trajectories of varying *amplitude* in SORT were replaced with linear trajectories of varying *orientation* that were directed upwards, horizontally, or downwards. When participants were required to produce a horizontal trajectory, watching an upward trajectory led to a *lower* movement-endpoint (i.e., *y*) position, whereas watching a downward trajectory led to a *higher* movement-endpoint position (see the top panel of Figure 3.3.2). The contrast effect is therefore not confined to the dimension of movement amplitude.

The Time Course of the Contrast Effect

Schubö et al. (2001) had found that the contrast effect was already present after about 1/4 of the produced movement length. This was also the case when linear trajectories of varying orientation were used (see the top panel of Figure 3.3.2). However, a more fine-grained analysis of the movement trajectories revealed that the contrast effect had the tendency to be preceded by an assimilation effect within a given action, that is, what was produced was "attracted by" what was perceived (see the bottom panel of Figure 3.3.2). Moreover, while this latter effect was essentially present for all participants, the contrast effect only had a tendency to manifest itself for those participants that reported being aware that they exhibited an assimilation effect. These new findings suggest that the contrast effect may be, at least in part, strategic in origin.

The Role of Dimensional Relevance

In another series of experiments using linear trajectories, the orientation of the stimulus trajectory was made irrelevant by eliminating the response on the subsequent trial. However, participants still had to watch the trajectory because they were required to report whether the light point had briefly changed color or not, which occurred on a random half of the trials. Under these conditions, an assimilation effect was present in the early portion of the movement trajectories, but no evidence for a contrast effect was obtained. These results support the notion that the assimilation effect is probably the more "automatic" of the two and that the contrast effect is only obtained when the feature-overlapping dimension of the stimulus is relevant for a subsequent action.

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Schubö, A., Prinz, W., & Aschersleben, G. (in press). Perceiving while acting: Action affects perception. *Psychological Research.*

Section 4: Planning and Control of Actions and Events

Iring Koch, Till Vierkant, Edmund Wascher, Andrea Philipp, Thomas Splett
Stefanie Schuch, Wolfgang Prinz, Peter Keller, Gisa Aschersleben

Introduction

Actions serve to fulfill intentions. That is, the functional role of action is to achieve an intended or desired goal in a specific situation. This holds, from life plans through to even the most simple reaction time (RT) experiment, because task instructions must induce, prior to the experimental task, the participant's intention to act (e.g., by pressing a response button) when a specific stimulus event occurs. In general, actions and events are organized in terms of intentions and tasks. To accomplish this organization, the cognitive system must be able to establish a relatively permanent representation of a task. It is this task representation that determines how stimulus events and actions are to be bound together in a given, prespecified situation. In this sense, task instructions serve to establish the appropriate cognitive representation of the task at hand, which is a necessary prerequisite for psychological experiments. However, although such cueing of intentions by way of explicit instructions often also occurs outside of experimental contexts, it seems that intentions can also be activated endogenously, that is, without being triggered by explicit cues. Analyzing and understanding how such task representations are established and maintained is a major goal of cognitive psychology.

Recent developments in cognitive psychology see task representations as serving the role of higher order, "executive" control structures. In a rapidly growing literature, such executive control structures have been termed "task sets." These are action-related memory structures that specify which out of a potentially large range of stimulus events in a situation are relevant, how these are to be interpreted, and which action should be executed to achieve the intended goal.

Research Questions

This fairly general characterization of the role of task sets in the control of actions and the interpretation of events leads to a number of more specific research questions. Examples are the following: What are the temporal dynamics of establishing or changing a task set? Which components of task sets can be activated in memory prior to actual stimulus presentation to prepare in advance for the task? What is the microstructure of a task set, that is, does it comprise specific stimulus-response (S-R) "bindings" that may be re-activated upon presentation of that very stimulus? How can task sets be shielded from such interference in order to properly perform the intended task? Can task sets lead to involuntary persistence of actions although the situation has changed so that the action is no longer functional? Furthermore, how can movement cues in the environment induce actions in observers, and what differentiates intended actions from more reactive actions? Finally, the fairly general definition of task sets leaves it open how we should understand the relationship between this approach to action control and our traditional folk psychological idea of action being controlled by the conscious self? These questions have been addressed in different classes of experimental paradigms, which will be described briefly.

Projects

A major experimental approach to investigate "executive" control of task set is the "task switching" paradigm. Here, a condition in which a task is repeated is compared to one in which the task (i.e., the intention) is switched. In the "cueing" paradigm, the task sequence is random, but each stimulus is preceded by an instructional cue. Alternatively, tasks can be presented in a simple and predictable order (e.g., AABBAABB, and so on), so that explicit cues are not necessary. Disregarding the specifics of the paradigm, the typical finding is that RTs and error rates are higher in the task switch condition than in the task repetition condition, demonstrating "switch costs" (see Figure 4.0.1).

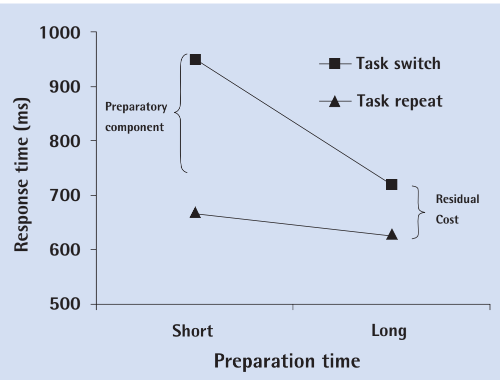

Figure 4.0.1: Illustration of typical data in the task-switching paradigm.

Recent research has shown that these "switch costs" have different components. One is a "preparatory" component that is commonly understood as reflecting the processing demands that configuring the cognitive system for the new task places on "executive control functions" (i.e., to maintain or shift the task set). The other component of switch costs is a "residual" component that may be due to a variety of processes, such as involuntarily persisting activation or inhibition of the respective task set(s), episodic retrieval of S-R bindings, or response conflicts, leading to interference effects. Several projects using the task-switching paradigm aim at differentiating these processes and, thus, at extending our knowledge about how cognitive processes are controlled. These projects are described below in more detail.

Furthermore, task sets may, under certain conditions, involuntarily be activated by contents of perception, such as by movement cues. This conclusion can be drawn from the results of our research on ideomotor action (e.g., Knuf, Aschersleben & Prinz, 2001, *JEP:G, 130,* 779-98). Our participants could only observe, but not manipulate, the movement of a ball on a computer screen. Although instrumentally completely ineffective, the participants moved their bodies as if to exert some kind of magical impact on the moving ball – a classical example of ideomotor action. The majority of these induced movements could be shown to be intentionally guided, though weaker effects of perceptual induction were found as well.

In another project, we try to equate the experimental conditions for intended and reactive actions, and seek to identify behavioral and electrophysiological signatures of intentional actions. The behavioral data show that reactions were shifted towards their triggering stimuli, whereas intended actions were shifted towards their anticipated effects. Electrophysiological data appear to suggest that the intention to perform an action does not occur until after that action has been selected and its execution fully prepared.

Finally, we look at the concept of the conscious self to better understand how modern concepts of action control in cognitive psychology and traditional folk-psychological concepts are related to each other. There is mounting empirical evidence that the connections between conscious representations and the execution of actions might be far more indirect than we commonly assume in everyday life. Also, there are more and more philosophical theories that question the very concept of the conscious self that seems so obvious to us. What ontological status could this entity have? Is it psychological, normative, or does it maybe not exist at all? What practical normative consequences would either answer have? Two philosophical projects examine these conceptual issues.

4.1. Endogenous Preparation in the Control of Task Set

Thomas Goschke
Iring Koch

Supported by grants GO 720/3-1 and GR 1950/1-1 of the Deutsche Forschungsgemeinschaft, Priority Program 1107 Executive Functions.

In this project we investigate the role of preparation in task switching by manipulating the task-preparation interval. In random task sequences with tasks precued on a trial-by-trial basis, prolonging the cue-stimulus interval often reduces shift costs, indicating that task sets can be activated in advance. Furthermore, prolonging the time for decay of task-set activation (i.e., the response-cue interval) also reduces shift costs, presumably because less residual activation needs to be overcome when switching to a different task (Koch, 2001).

In an earlier series of experiments, we (Goschke, 2000, *A&P XVIII,* 331-355) obtained evidence that advance preparation consists in part in the *retrieval of a verbal task representation* into working memory. Participants either had to respond repeatedly to the color or the identity of letters, or they had to alternate between the two tasks. When participants verbalized the next task ("letter" or "color") during the response-stimulus interval and prior to the imperative stimulus, switch costs were reliably reduced compared to when they were given no time to prepare. Importantly, this reduction of the switch cost was completely eliminated when task verbalization was prevented by an articulatory suppression task. This indicates that the retrieval of a verbal task representation is an important component of advance task-set reconfiguration (cf. Goschke, 2003). In a more recent event-related fMRI study performed in collaboration with Oliver Gruber (Saarland University Hospital and MPI of Cognitive Neuroscience, Leipzig) we investigated whether advance preparation engages cortical regions also involved in verbal rehearsal. Participants categorized geometric objects according to either shape or color. By manipulating the cue-target interval in a range between 0 and 1500 ms it was possible to dissociate brain activity changes related to the processing of either the cue or the target. Analyses performed so far have revealed increased activation during advance preparation in left premotor and parietal cortical brain regions that have been associated with verbal rehearsal.

In other experiments we observed that preparation in simple, predictable task sequences (AABBAABB, and so on) is based primarily on external cues, if they are provided. For instance, in one experiment (Koch, 2003), two groups of participants switched between two tasks. In one group, they could rely on the predictable sequence only, whereas redundant external task cues were presented in another group. Longer preparation time had much stronger effects with external cues compared to the other group, suggesting that endogenously preparing for a task switch is difficult if it is not triggered by an external cue.

This conclusion is supported by experiments exploring whether incidentally learned task predictions help to prepare a task (Koch, 2001). Participants performed a complex repeating 9-trial task sequence. When this task sequence was changed, negative transfer occurred indicating task preparation based on task-sequence learning. However, the preparation effect did not differ for task shifts and repetitions, suggesting that sequence-based self-generated cues are primarily used for *task-specific* preparation, but not for specifically preparing a task *switch* (see Figure 4.1.1).

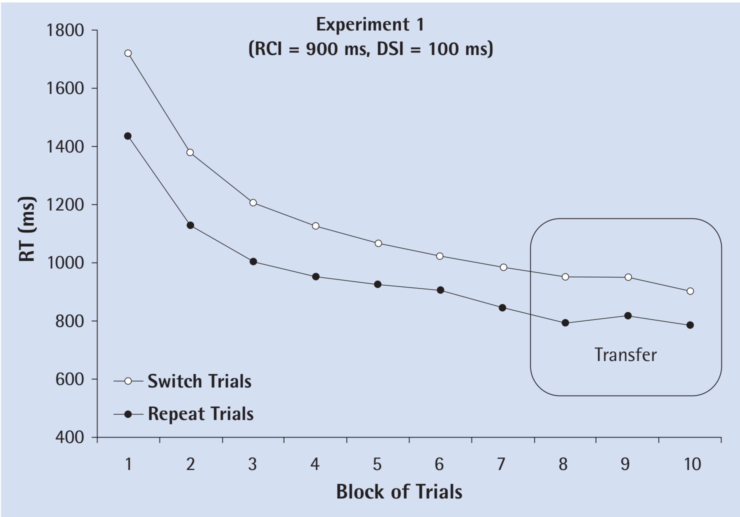

Figure 4.1.1: Mean RT (in ms) as a function of trial type (switch vs. repeat) and blocks of trials. The task sequence presented in Block 9 differed from that in the other blocks. (From Koch, 2001, Experiment 1).

In another study (Koch, subm.), we attempted to rule out that the switch-unspecificity of the preparation effect was merely due to the fact that task-sequence learning was incidental and preparation was therefore based on "implicit" learning. An easy alternating-runs sequence (AABB) was used and participants were explicitly informed about its existence. Nevertheless, the negative transfer effect due to a sequence change, which was much larger than that found in incidental learning studies, again did not differ between task shifts and repetitions (see Figure 4.1.2). This indicates that the shift-unspecificity is due to the nature of the cue on which preparation is based (i.e., sequential predictability) rather than whether learning is incidental or intentional. In conclusion, self-generated cues based on task sequence information lead primarily (but not necessarily exclusively) to task-specific preparation.

In collaboration with the MPI of Cognitive Neuroscience in Leipzig, we also developed a new paradigm to investigate task-preparation processes. Participants are either provided with a task-specific cue or with a serial transition cue that only indicates task repetition or switch instead of revealing directly the identity of the upcoming task. With this manipulation, the more "endogenous" component of retrieving the upcoming task from memory for previous tasks can be explored. The results indicate larger shift costs as well as larger preparation benefits with serial transition cues as compared to task cues (Forstmann, Koch, & Braß, subm.), suggesting that time-consuming retrieval processes contribute to endogenous task preparation. Preliminary analyses of recent fMRI data obtained with this paradigm seem to imply a prefronto-parietal network in the endogenous generation of task sets.

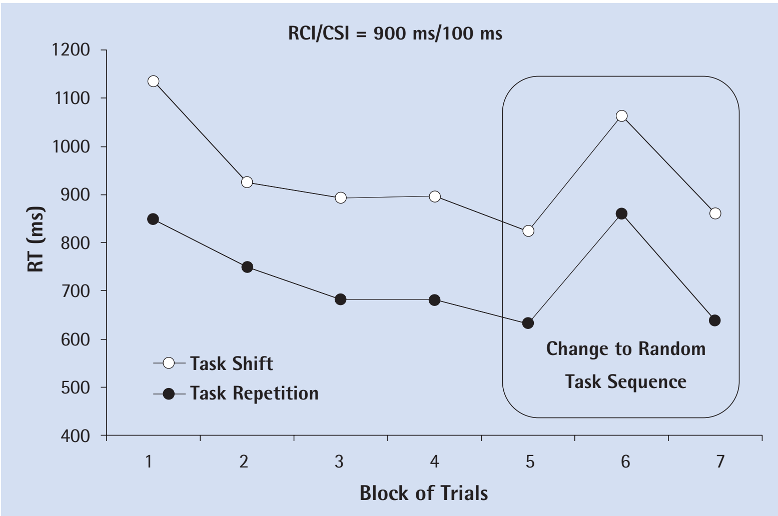

Figure 4.1.2: Mean RT as a function of block of trials and trial type (switch vs. repetition). Predictable task sequence in Blocks 1-5 and 7; random task sequence in Block 6. (From Koch, subm.).

Forstmann, B., Koch, I., & Braß, M. (subm.). *Endogenous control in task switching: A new experimental approach.*

Goschke, T. (2003). Voluntary action and cognitive control from a cognitive neuroscience perspective. In S. Maasen, W. Prinz, & G. Roth (Eds.), *Voluntary action: Brains, minds, and sociality* (pp. 49-85). Oxford: Oxford University Press.

Koch, I. (2001). Automatic and intentional activation of task sets. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 27(6),* 1474-1486.

Koch, I. (2003). The role of external cues for endogenous advance reconfiguration in task switching. *Psychonomic Bulletin & Review, 10,* 488-492.

Koch, I. (subm.). *Sequential task predictability in task switching: Evidence from explicit learning of task sequence.*

4.2. Control of Action Selection in Changing Task Contexts

Thomas Goschke
Iring Koch
Andrea M. Philipp
Stefanie Schuch

Involuntary Carry-Over Effects of Previous Task Sets

We investigated whether part of the "residual" switch cost (see Figure 4.0.1) is due to both persisting activation and inhibition of task sets. We assumed that inhibitory processes are triggered primarily when a stimulus elicits a response conflict ("conflict-triggered control" hypothesis; Goschke, 2000, *A&P XVIII*, 331-55; Goschke, 2003). This was tested in experiments (Goschke, subm.) in which participants responded either to the identity or color of letters.

On each trial a task-cue signaled the next task, with the cue-stimulus-interval (CSI) and the response-cue-interval (RCI) being either 250 or 1500 ms. We manipulated the presence of response conflicts on the preceding trial: one third of the trials were preceded by a congruent trial (i.e., letter identity and its color were mapped to the same response; no response conflict), one third were preceded by a neutral trial (i.e., the task-irrelevant stimulus dimension was not mapped to any response), and one third of the trials were preceded by an incongruent trial (conflict condition). RTs were increased on task-switch trials *preceded* by incongruent (as compared to congruent or neutral) trials, suggesting persisting inhibition of the previously distracting stimulus dimension, whereas no such effect was present on repeat trials. This carry-over effect was not affected by task preparation (i.e., CSI), indicating that inhibition was released only when the next stimulus was processed (Figure 4.2.1). In conclusion, part of the residual switch costs appears to reflect persisting inhibition of competing task sets and/or distracting stimulus dimensions, suggesting that the cognitive system adjusts cognitive control processes in a context-sensitive manner depending on the degree of response conflicts elicited in a task.

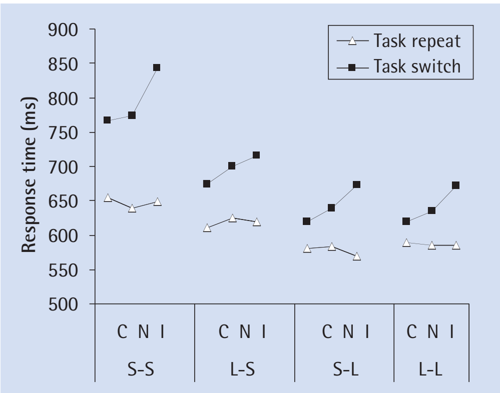

Figure 4.2.1: Mean RT for task-switch and task-repeat trials preceded by response-congruent (C), incongruent (I), and neutral (N) trials for four different combinations of RCI and CSI (S = short; L = long).

In collaboration with Oliver Gruber (Saarland University Hospital and Max-Planck-Institute of Cognitive Neuroscience, Leipzig), we used event-related fMRI to investigate the neural correlates of conflict-triggered control processes. Incongruent trials were associated with reliable activation increases in the medial frontal cortex (Brodmann area 8m) adjacent to the anterior cingulate cortex (ACC), but not of the ACC itself. This finding indicates that the ACC and adjacent medial frontal brain areas may have distinct functions in the detection of response conflicts and the regulation of cognitive control.

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The Relation of Task Inhibition and Action Selection

We further explored the conditions that trigger task inhibition in experiments using a no-go methodology (Koch & Philipp, subm.; Philipp & Koch, subm.; Schuch & Koch, 2003).

We hypothesized that inhibition of competing tasks is due to the need to select a response in the face of interfering alternative tasks. To test this, we had participants always prepare for the next task, but occasionally and unpredictably they had to withhold their response. On such trials, task preparation was not accompanied by response selection. We found that shift costs disappeared after no-go trials, whereas there were clear shift costs after go trials, suggesting that inhibition of competing tasks occurs only when a response must be selected.

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In further experiments, we investigated task inhibition by comparing performance in a task sequence CBA with that in ABA. Typically, performance is worse in ABA than in CBA, suggesting the influence of persisting task inhibition (cf. Mayr & Keele, 2000, *JEP:G, 129(1)*, 4-26), which produces costs when tasks have to be re-activated. This inhibition effect was largely reduced when the preceding trial did not require response selection (Schuch & Koch, 2003; see Figure 4.2.2).

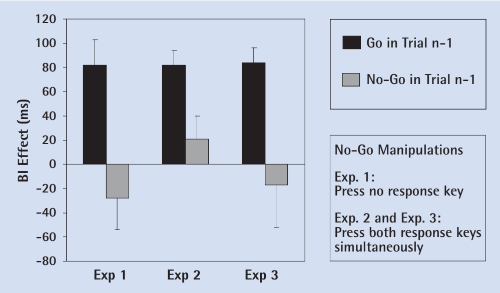

Figure 4.2.2: Task inhibition after go and no-go trials in three experiments.

The task-inhibition effect can also be found when participants switch between an unconditional double-press response (similar to a simple-RT task) and two choice-response tasks, suggesting that inhibitory processes operate also at the level of manual response mode (Koch, Gade, & Philipp, in press). Currently, we aim to further specify the functional locus of interference resolution by introducing different response modalities (e.g., manual vs. verbal).

Action Coding in Dual Tasks

So far, we have considered interference on the level of whole sets of rules (e.g., parity rule: odd-left; even-right). Interference can also be observed on the level of the individual rule, especially when two different rules refer to the same response (e.g., odd-left vs. smaller than 5-left). To investigate this interference, we focus on effects of response-repetition. In changing task contexts, costs of response repetition relative to response shift occur (e.g., Rogers & Monsell, 1995, *JEP:G, 124(2),* 207-31). We investigated response-repetition costs in a dual-task psychological-refractory period (PRP) paradigm (Schuch & Koch, in press). Both the first and the second task had to be responded to with the same two response keys. We found costs of response repetition relative to response alternation so that the C-R rules changed from the first to the second task, whereas there was no such cost when participants performed the same task twice (no change of rules). We assume that the response-repetition cost is based on a process that recodes the abstract response code (e.g., “left” as indicating a “smaller than 5”-judgment rather than an “odd”-judgment). The finding that the same pattern of results occurs also with response-response compatibility further supports this assumption. To show this, we changed the response requirements for the first task. Participants responded verbally, by saying “left” or “right,” whereas they pressed a left or right response key in the second task. Further data suggest that the change of response codes takes place in the course of response selection, and a previous response code is abolished only in the course selecting another response code. We are currently investigating the generality of the interference-of-response-codes principle also in other paradigms.

Neural Basis of Response Recoding

In a cooperation project, the neural basis of changing response meanings was investigated using fMRI. We used a condition in which two different tasks are mapped onto the same set of responses, so that recoding of these responses is necessary (cf. Ruge, Braß, Koch, Rubin, Meiran, & von Cramon, subm.), and compared performance in this bivalent-response condition with that in another condition where participants used separate sets of responses for each task, so that response recoding was not required. Behavioral data show higher task-shift costs when response recoding was necessary, and fMRI data revealed the involvement of the lateral prefrontal cortex in this recoding of response meanings (Braß, Ruge, Meiran, Rubin, Koch, Zysset, et al., 2003). In this project, we also showed that the experimental setting in the fMRI scanner led to a general increase of RT, but that complex, predicted interactions in behavioral data can be replicated across settings, suggesting functional equivalence of cognitive control processes in task switching inside and outside the scanner (Koch, Ruge, Braß, Rubin, Meiran, & Prinz, 2003).

Braß, M., Ruge, H., Meiran, N., Rubin, O., Koch, I., Zysset, S., et al. (2003). When the same response has different meanings: Recoding the response meaning in the lateral prefrontal cortex. *NeuroImage, 20(2),* 1026-1031.

Goschke, T. (2003). Voluntary action and cognitive control from a cognitive neuroscience perspective. In S. Maasen, W. Prinz, & G. Roth (Eds.), *Voluntary action: Brains, minds, and sociality* (pp. 49-85). Oxford: Oxford University Press.

Goschke, T. (subm.). *Conflict and control: Dynamic regulation of goal shielding in task-set switching.*

Koch, I., Gade, M., & Philipp, A. M. (in press). Inhibition of response mode in task switching. *Experimental Psychology.*

Koch, I., & Philipp, A. M. (subm.). *Effects of response selection on the task-repetition benefit in task switching.*

Koch, I., Ruge, H., Braß, M., Rubin, O., Meiran, N., & Prinz, W. (2003). Equivalence of cognitive processes in brain-imaging and behavioral studies: Evidence from task switching. *NeuroImage, 20(1),* 572-577.

Philipp, A. M., & Koch, I. (subm.). *The relation of task inhibition and task activation in task switching.*

Ruge, H., Braß, M., Koch, I., Rubin, O., & von Cramon, D. Y. (subm.). *Reconciling advance preparation with proactive interference in task switching: Insights from BOLD fMRI.*

Schuch, S., & Koch, I. (2003). The role of response selection for inhibition of task sets in task shifting. *Journal of Experimental Psychology: Human Perception and Performance, 29,* 92-105.

Schuch, S., & Koch, I. (in press). The costs of changing the representation of action: Response repetition and response-response compatibility in dual tasks. *Journal of Experimental Psychology: Human Perception and Performance.*

Supported by the German Israeli Foundation (GIF). Participating institutions are the MPI of Cognitive Neuroscience in Leipzig (von Cramon & Braß), the Ben Gurion University at Beer Sheva, Israel (Meiran), and our institute (Prinz & Koch, counseled by Hommel, Leiden, NL).

4.3. The Role of Episodic S-R Bindings in Task-Switch Costs

Iring Koch
Florian Waszak

Task-switch costs have been proposed to reflect a kind of "task-set" reconfiguration needed to intentionally prepare the cognitive system for the new task. However, Allport and Wylie (2000, *A&P XVIII,* 35-70) have suggested a retrieval account of shift costs, assuming that previously appropriate task sets may be automatically retrieved from memory when stimuli recently associated with these sets are presented, thereby creating a conflict with the currently appropriate set. This approach emphasizes the role of stimulus repetition and of the bindings between stimulus and task set. It predicts that shift costs should be largely reduced if the stimuli used did not yet occur in the context of another task.

We examined this prediction in a series of experiments (Hommel, Pösse, & Waszak, 2000, *Psychol Belgica, 40,* 227-45; Waszak, Hommel, & Allport, 2003, subm.). Participants named pictures and read words in response to incongruent picture-word stimuli (see Figure 4.3.1), switching task every second or third trial. Some of the stimuli were presented in both tasks, *p*icture-naming and *w*ord-reading (set PW), whereas other stimuli were presented for *w*ord-reading *o*nly (set WO). Figure 4.3.2 shows the results of Experiment 1 from Waszak et al. (2003). Stimuli presented in both tasks (PW) showed significantly larger shift costs than WO stimuli. Further experiments (Waszak et al., 2003, Experiments 3 and 4) revealed that this effect survives a large number of intervening trials. Furthermore, we found that presenting a stimulus several times in picture-naming (before the occurrence of the same stimulus in word-reading) yields larger shift costs than presenting the stimulus once in picture-naming and later on once in word-reading (Waszak et al., 2003, Experiment 2).

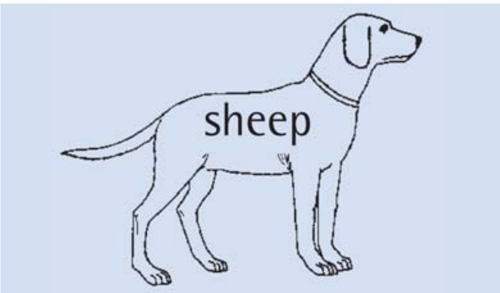

Figure 4.3.1: Typical picture-word Stroop stimulus.

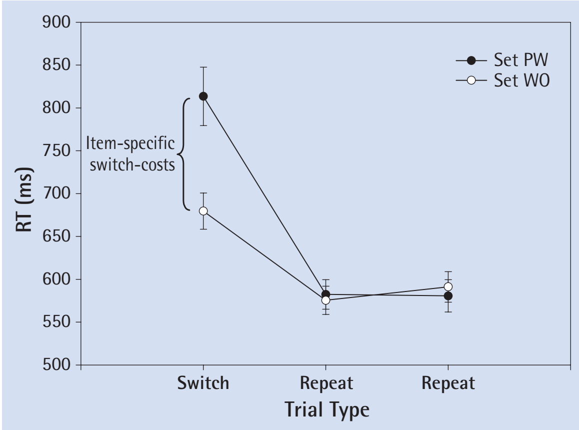

Figure 4.3.2: Data from Waszak, Hommel, & Allport (2003, Experiment 1): Mean RTs for word-reading as a function of trial (switch, two repeats) and item set (set PW and set WO).

These results cannot be explained in terms of an intentional, preparatory mechanism. Rather, they suggest that the cognitive system stores a memory trace combining stimulus-specific information with information about the particular task context (picture-naming in this case). When the stimulus appears again, it triggers the retrieval of the associated task set, which then competes with the currently selected and/or actually needed set. The more traces involving one task (picture-naming) accumulate in memory, or the stronger they are, the more impaired the performance when the stimuli are presented during the other task (word-reading). That this interference is indeed – at least partially – due to some stimulus-task association, and not merely due to the retrieval of stimulus-response bindings, was demonstrated in Experiment 5 from Waszak et al. (2003). In this experiment, word-reading performance in response to stimuli previously presented in picture-naming was impaired even under response-congruent conditions.

In a more recent series of experiments, we demonstrated that the stimulus-specific priming effect is based on two different factors: first, the facilitation of distracting stimuli (competitor-priming), and, second, impaired processing of previously suppressed responses (negative-priming; Waszak et al., subm.). Moreover, we found that the task-priming effects generalize to semantically related stimuli, suggesting that possibly most or all residual shift costs reflect some sort of generalized proactive interference from previous stimulus-task episodes.

In another series of experiments using an explicit cuing paradigm with random task sequences, we (Koch & Allport, subm.) explored such stimulus-specific priming effects in a pair of numerical judgment tasks. In the first part of the experiment, all digits were consistently mapped to only one task (e.g., "odd-even" judgment), so that digits should become associated with specific tasks. This should lead to stimulus-based priming of task that facilitates task performance based on an explicit task cue. In a negative transfer phase, the consistent stimulus-task mapping was reversed (e.g., the digit then occurred with "greater-smaller" judgment), so that stimuli associatively activate the incorrect, competing task after the mapping reversal. The results show that RT level greatly increased with mapping reversal, indicating a substantial impact of stimulus-based priming. This impact was stronger for task switches than for task repetitions, resulting in increased shift costs. Importantly, this effect was substantial also in congruent trials, in which the response is the same in both tasks, confirming that stimulus-based priming primarily operates at the level of stimulus-task associations rather than S-R bindings.

In a next step, we tested whether this presumably involuntary stimulus-specific component of shift costs interacts with intentional task preparation. To this end, we manipulated the cue-based preparation interval. We found that intentional (i.e., cue-based) preparation greatly attenuated the impact of stimulus-based priming in general RT level, and it virtually eliminated its impact in shift costs. This substantial influence of intentional preparation on stimulus-based priming effects suggests that task preparation serves to prime (or "bias") the cognitive system such that the representation of the upcoming task becomes so dominant over competing task representation during the preparation interval that stimulus-elicited conflict between tasks is either largely prevented or can be settled very quickly. This suggests that task-switching performance is governed by the interaction of intentional (cue-based) biasing processes and involuntary priming processes.

Similar experiments using alphabetic arithmetic (AA) tasks (Koch, Prinz, & Allport, subm.) were run to explore whether stimulus-based task priming also affects task "mixing" costs. Mixing costs denote the increase of RT when participants have to switch tasks as compared to when they perform one and the same task in "pure" blocks, and this effect can be attributed to the costs of holding two tasks in working memory compared with only one task in pure, single-task blocks. The AA tasks required participants to either subtract one element from a stimulus letter in the alphabet ("minus" task; e.g.: C → B) or to add one element ("plus" task: C → D) and verbalize the response. Stimuli were either mapped to one task or the other, as in previous experiments, and the impact of stimulus-based priming was assessed in both pure and switching blocks. We found that stimulus-based priming affected performance in mixed, task-switching blocks more than in pure, single-task blocks. This finding reinforces our previous conclusion that stimulus-based priming can impair task-switching performance in a way that is not easily captured by theoretical accounts emphasizing active, intentional advance preparation of task set. It will be crucial in future research to specify whether intentional preparation and involuntary priming effects are based on independent mechanisms or whether they can be explained within a common, unifying framework.

Koch, I., & Allport, A. (subm.). *Cue-based and stimulus-based priming of tasks in task switching.*

Koch, I., Prinz, W., & Allport, A. (subm.). *Item-specific mapping costs in alphabetic arithmetic tasks: Effects on mixing costs and shift costs.*

Waszak, F., Hommel, B., & Allport, A. (2003). Task-switching and long-term priming: Role of episodic S-R bindings in task-shift costs. *Cognitive Psychology, 46(4),* 361-413.

Waszak, F., Hommel, B., & Allport, A. (subm.). *Task-switching: Role of negative and competitor priming in task-shift costs.*

4.4. Ideomotor Action

Sara de Maeght
Lothar Knuf
Wolfgang Prinz

Ideomotor movements may be induced in observers when they watch other people's actions. We study how induced actions are related to observed actions.

This project addresses the issue of how external movement cues can control involuntary actions, termed "ideomotor" actions. Ideomotor actions may arise in observers while they are watching certain events unfold. Classical examples refer to movements induced by watching other people's actions, or their outcomes (Figure 4.4.1). In previous research, we developed a bowling-game paradigm for studying how the induced actions are related to the events inducing them (Figure 4.4.2). We identified two principles governing that relationship: perceptual induction and intentional induction. We speak of perceptual induction when observers move in accordance with *what they see* happening. Intentional induction occurs if the triggered movement is in accordance with *what the observer would like to see* happening. The results indicated that aftereffects of the hand's previous involvement in instrumental action may act to suppress perceptual induction for a while (Knuf, Aschersleben, & Prinz, 2001).

Figure 4.4.1: Observers who watch other people's actions often cannot refrain from acting spontaneously themselves.

The present research aimed at extending previous findings in two major directions. The first extension aimed at clarifying the notion of intentional induction. In our paradigm, intentions could, in principle, refer to proximal body movements (hand on joystick) and/or these movements' distal environmental effects (ball on screen). In one experiment, we attempted to separate the contributions from these two levels of intentional reference: We reversed the relationship between the two movements such that hand movements to the left would lead to ball movements to the right, etc. Results indicated a clear dissociation: Induced hand movements were governed by proximal intentions (referring to desired hand movements) whereas induced head movements were governed by distal intentions (referring to desired ball movements). This finding supports the notion that, in hands, induced movements may be confounded with aftereffects of previous instrumental action, whereas no such aftereffects apply to head movements.

The second extension was to apply the paradigm to a situation in which observers watch the outcome of somebody else's preceding action (rather than their own). The new version of the paradigm had two parts. First, participants practiced the bowling game – actually a replication of previous experiments. In the second part, they acted as mere observers, watching the bowling game as it was played by an (alleged) co-participant. This task allows us to study the mechanics of action induction unconfounded with aftereffects of previous instrumental action. Results indicated additive effects of perceptual and intentional induction. As expected, results were same for hand and head movements, suggesting that hands are no longer special when they play no instrumental role.

We conclude that people tend to perform, in their own actions, what they see being performed by others. In this sense, perceiving external movement cues can induce ideomotor actions. Yet, what the observer perceives being performed by others always pertains to both the other actions' "physical surface" and the underlying intentional subtext. In other words, when people perceive what others are doing they cannot help but also perceive what the other person is aiming at.

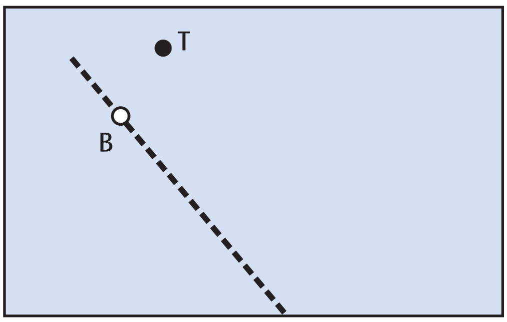

Figure 4.4.2: A screen shot from our experimental bowling game showing the rolling ball (B) heading towards the stationary target (T) but missing it on its left-hand side. Here, perceptual induction predicts induced movements to the left (in accordance with the ball's actual trajectory), whereas intentional induction predicts induced movements to the right (in accordance with its desired trajectory).

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Knuf, L., Aschersleben, G., & Prinz, W. (2001). An analysis of ideomotor action. *Journal of Experimental Psychology: General, 130(4),* 779-798.

Prinz, W., de Maeght, S., & Knuf, L. (in press). Intention in action. In G. W. Humphreys & J. Riddoch (Eds.), *Attention in action: Advances from cognitive neuroscience.* Hove, UK: Psychology Press.

4.5. Intentional and Reactive Components of Action Control

Gisa Aschersleben
Peter Keller
Iring Koch
Wolfgang Prinz
Edmund Wascher
Florian Waszak

People interact with their environment in two fundamentally different ways: They either actively manipulate environmental conditions or they respond to environmental changes that occur independently of their actions. The former type of interaction is frequently termed "intentional action," whereas the latter is "reaction." This project investigates, in collaboration with D.A. Rosenbaum (Pennsylvania State University, USA), whether the same movement produces distinct patterns of brain activity depending on whether it is performed as an action or a reaction.

The experimental task involved making key-press movements at the midpoint between adjacent items in evenly timed series of visually presented stimuli. Thus, stimuli and movements alternated in runs composed of 35 stimulus-movement pairings. The inter-stimulus interval (ISI) was 1200 ms, and participants were required to perform the movements so as to "bisect" this interval. Stimuli were presented at locations on a computer screen that corresponded to the spatial layout of the keys on the response box. In the *action* condition, participants were instructed to make key-presses so as to produce a random sequence of stimuli: The identity of each key-press determined the location of the subsequent stimulus. In the *reaction* condition, by contrast, participants were required to press the key that corresponds to the immediately preceding stimulus (see Figure 4.5.1). To keep constant the degree of movement alternation in both conditions, the movements in a given reaction run were yoked (in a disguised fashion) to the movements produced in a preceding action run. We collected both behavioral (movement timing) and electrophysiological (EEG) data.

The behavioral data revealed that movements occurred about 60 ms earlier in the reaction condition than in the action condition, that is, reactions were shifted towards their triggering stimuli, whereas actions were shifted towards their anticipated effects. This result is consistent with the idea that the perceptual representation of a given environmental event is bound together with the

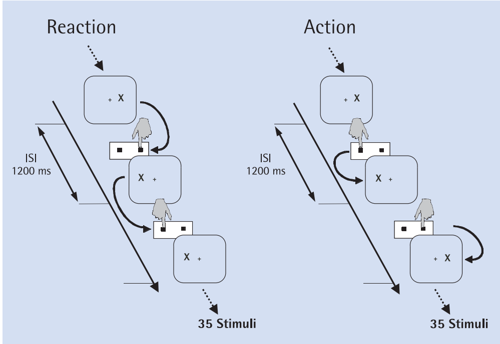

Figure 4.5.1: Illustration of the action and reaction conditions. ISI = inter-stimulus interval.

representation of the motor processes that drive behavior related to that event (see Sections 5.1 and 5.2).

Two movement-related components of the EEG data were examined, one that presumably reflects a Readiness Potential (RP, an index of the cortical preparation for voluntary movement *in general*) and another, the Lateralized Readiness Potential (LRP, reflecting the final activation and execution of a *specific* motor act). We observed an interesting dissociation between these two components. Whereas actions and reactions had similar LRP onsets, the RP started much earlier for actions than for reactions (see Figure 4.5.2). Moreover, the waveforms for the RP in the two conditions do not diverge until the LRP is already present. This suggests that the intention to perform an action does not occur until after that action has been selected and its execution fully prepared. Additionally, variations in stimulus-related ERP components support the notion of the binding between an action and its perceptual triggers or consequences.

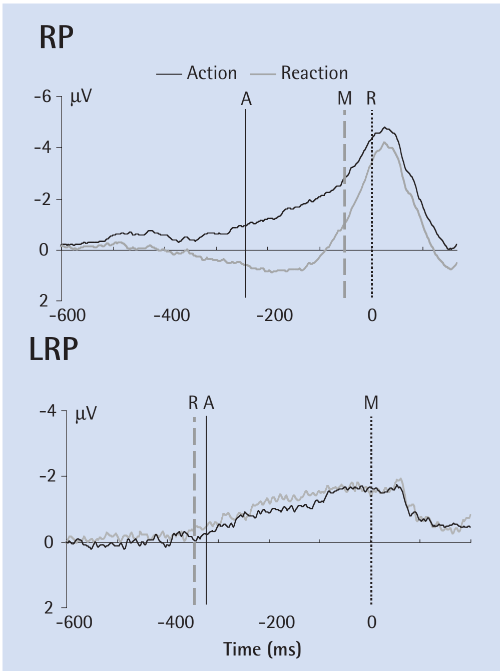

Figure 4.5.2: EEG results: RPs (top panel) and LRPs (bottom panel) in action and reaction conditions.
A = action component onset
R = reaction component onset
M = actual movement onset

Waszak, F., Wascher, E., Aschersleben, G., Koch, I., Prinz, W., & Rosenbaum, D. A. (subm.). *When do we want what we intend to do? Measurement of voluntary action components.*

4.6. Voluntary Action: Investigations into the Nature and Culture of Volition

Wolfgang Prinz
Thomas Splett
Till Vierkant

Introduction

This interdisciplinary project aims at an understanding of the connection between the conscious self and voluntary action. Investigating this relationship seems crucial not only for the progress of our scientific understanding of human action control, but also because the willing subject is a practical assumption in most discourses of social life (for an anthology that shows the interdisciplinary scope, see Maasen, Prinz, & Roth, 2003). In folk psychology, it seems indubitable that a conscious self is at the heart of volition, cognition, and action, and even in many fields of scientific psychology it remains unquestioned that there must be something like the actions of a conscious self. Such a self seems to be an assumption in theories ranging from justifications of democracy to criminal responsibility. This is disturbing in the light of results from neurophysiology, psychology, ethnology, and philosophy, which all point towards a very different picture of the human self. This is the self that Daniel Dennett (1991, Consciousness explained) famously labeled the 'fictional self.' Dennett's picture suggests that the self is not at all in charge of our actions but rather an inactive spectator. If Dennett is right and the conscious self is only a fiction, this would have dramatic consequences for some of our most cherished social institutions. However, these consequences are not inevitable. As, for instance, Vierkant (2003) argued, it is far from clear whether the conscious self is the only or even the most important self-concept that underlies our social institutions.

This project is supposed to provide tools which facilitate answers to the pressing challenges of societal self-understanding as well as to better understand the challenges themselves. Even though in everyday life it seems easy to distinguish between actions that are a consequence of our intentions (e.g., making coffee) and actions that happen to us unintentionally or even despite our intentions (spilling the coffee) the question of what the nature of willing might be is among the most notoriously difficult ones in the sciences as well as in philosophy.

Bearing that difficulty in mind, the project defines for itself a working definition of voluntariness which on the one hand is compatible with standard philosophical and psychological definitions, but on the other hand is wide enough to allow for the different uses of the term within our subprojects. Traditionally, willed actions have been defined as those actions which are not like reflexes, stimulus-dependent automatisms, and habitual actions in that they have the specific characteristic that they are aiming at goals. That is, they are characterized by the fact that they rely on representations of desired effects of actions. Such effects range from immediate consequences like switching the light on to long-term ones like going on holiday next year. Naturally, such a definition opens up a whole host of questions. The project tries to tackle at least some of them as its guiding research questions.

(1) To what extent is it possible to maintain philosophical conceptions of the conscious self as the first cause of our actions in the light of empirical evidence pointing to the contrary?

(2) How are voluntary actions initiated? Are conscious representations of intentions and goals causal conditions of voluntary actions? Could there be unconscious voluntary actions?

(3) Ontogenetically speaking, do we come to understand the concept of intentional action by observing our own mental life or by watching others?

(4) To what extent are the will and intentionality results of an ever-changing social and historical process of schooling and (self)-education? Are there any mutual exchanges between societal discourses at large and philosophical as well as psychological scientific practice?

(5) Does a new understanding of the role of the conscious self for voluntary actions affect our normative practices?

Interdisciplinarity

The interdisciplinary nature of the project requires multiple and different methods and concepts in the subprojects. Nevertheless, the common starting-point of the above-mentioned skepticism about a form of fundamentalism regarding the conscious self is used by each project as a basis to explore alternative concepts of voluntary action in their home disciplines. There are four subprojects situated at the Munich institute. In the following we will focus on the two philosophical subprojects, while the two psychological projects are reported in Section 4.5 and Research Unit 1 (Infant Cognition).

Apart from the projects situated at our Munich institute, the interdisciplinary project comprises two psychological projects at the Technical University of Dresden, one philosophical project at the University of Mainz and two sociological projects at the University of Basel. Two projects based in Dresden investigate the role of unconscious causes for the impression of conscious control and unconscious effects of conscious intentions. The interaction between conscious states and unconscious processes, investigated in both projects, is obviously of highest importance if one wants to understand why people come to believe that the conscious self is the origin of voluntariness even though it is not. Preliminary results show that it is possible to manipulate the conscious feeling of control by flashing certain unconscious primes at the participants. Together with older findings this could suggest that the impression of subjective control is based on fallible causal attribution and not on introspection alone. In Basel, sociologists are investigating how the willing of the conscious subject has been understood differently through the ages by studying self-help manuals designed to teach how to will properly. So far it appears that there is a strong connection between willing (self-leadership) and leading others. If this should be the case then what it is to will properly is determined by the political rationality of the historical period. A philosophical project based in Mainz aims at a theory of action that on the one hand explains the epistemic irreducibility of conscious volitions, but that is compatible with an ontological naturalistic monism as well.

Despite the very different questions the single projects address in their disciplines, more and more common threads are beginning to emerge. It has become clear that latest social psychological research on the use of conscious intentions overlaps to a large degree with the popular advice given in self-help books. From this follows the interesting question of where this overlap might stem from. Are the self-help books very well informed about current research or rather is it much more the case that both discourses draw on the same narrative social resources? All projects find that incompatibilist libertarian conceptions of the will do not fit the skeptical picture of conscious self that the projects are by now fleshing out in their disciplines. All projects also find that it will be crucial to establish the meaning of terms like 'goals' and 'intentions' on a personal and a subpersonal level and to investigate afterwards structural (dis)similarities between the terms. Joëlle Proust's article 'How voluntary are minimal actions' (2003, in Maasen et al.,

Voluntary Action: Investigations into the Nature and Culture of Volition (funded by VolkswagenStiftung)

Administrative Heads:
Thomas Goschke, Sabine Maasen, Wolfgang Prinz, and Wilhelm Vossenkuhl
Project Coordinator:
Till Vierkant

Projects Within Voluntary Action

Philosophy

Mainz

Bettina Walde: A philosophical conception of volition: Questions of epistemological irreducibility, epiphenomenalism, and cognitive science.

Munich

Thomas Splett: Does the will exist? Ontological perspectives on phenomena of will, especially on controversial aspects like unmotivated willing.

Till Vierkant: Conscious will and autonomy: On the relationship between the conscious self an the normative self with regard to free will.

Psychology

Munich

Petra Hauf: Interaction between self and other performed actions (see Research Unit 1/Infant Cognition).

Peter Keller: Intentional and reactive components of action control (see Section 4.5).

Dresden

Thomas Goschke, Katrin Linser, Juliane Wendt: Empirical approaches to volition: Unconscious factors in the impression of conscious control, unconscious effects of conscious intentions.

Sociology

Basel

Sabine Maasen, Barbara Sutter, Stephanie Duttweiler: From ‚Lessons on Will' to ‚Self-Management': On the social construction of the will. What is the role of the will in society? Analyses of the will in self-help literature from a sociology-of-knowledge perspective.

Voluntary action, 202-19) and ongoing discussions with her provide a promising step towards a satisfactory classification of the relationship. The philosophical projects based at the institute, which are outlined in the remainder of this section, particularly profit from this cooperation.

Conscious Will and Autonomy

This philosophical project uses traditional compatibilist argument types to show that the loss of a conscious self as unique causal starting point of willed human action does not imply the loss of human autonomy. The classical compatibilist Frankfurt style examples show convincingly that one can be morally responsible even if one could not have done otherwise. For example, suppose that Fred wants to send flowers to George. Unbeknownst to him there are aliens from Mars who can control his decision-making process and who also want it to happen that George gets the flowers. If Fred were about to decide that he does not want to send flowers to George after all, then the aliens would intervene and prevent him from changing his intention. As it is, Fred never wavers in his intention, and the aliens do not intervene. This classical argument shows that it is imaginable that someone has control in the relevant sense, even though he would not be able to do otherwise. This in turn shows that willing does not necessarily require a conscious self that starts causal chains out of nothingness.

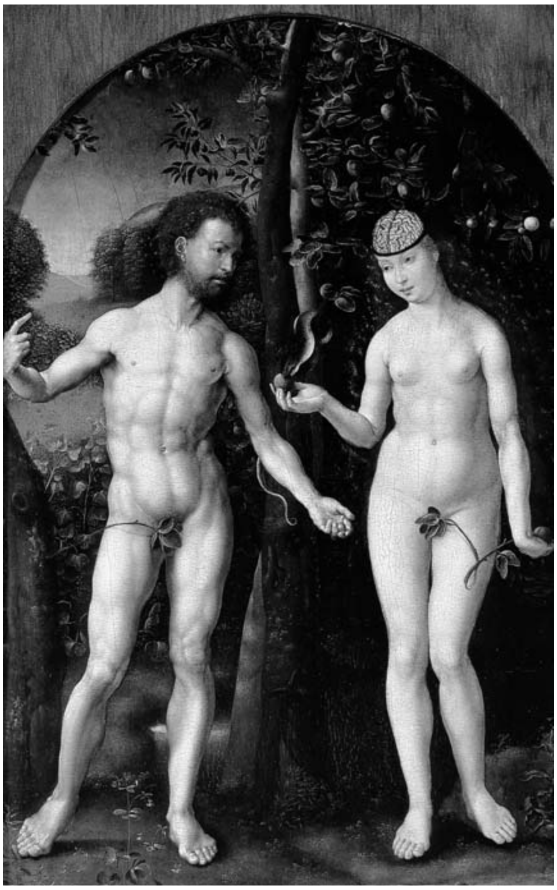

Figure 4.6.1: Did Eve take the apple on her own free will or was she predetermined by her brain to do so?

Nevertheless, classical compatibilism does leave many central questions unanswered. Even if it were true that human autonomy needs no self that can create causal chains out of nothingness, this still leaves the question unanswered which specific role the conscious self has to play for human autonomy. The project aims at filling in the blank spots in the compatibilist picture by establishing two claims. It seeks to show that human autonomy is fundamentally based on a moral realist understanding of a normative narrative self, and it seeks to explain the role of the conscious self within such a framework of autonomy.

The latter claim has not yet received much attention within the compatibilist community while the former claim is against the grain of standard philosophical systemizing, because compatibilism has been traditionally associated with moral anti-realism. The project holds that compatibilism can be fruitfully combined with moral realism; more than that, the project uses the concept of strong evaluations as the constitutive horizon for the narrative self, to the effect that a well thought-through compatibilist position *should* rely on moral realism, if it does not want to fall back on the pessimistic incompatibilist hard determinism.

The role of the conscious self has been extensively discussed for intentional action. Surprisingly enough though, this has not been reflected in the discussions surrounding autonomous action. The project will try to establish an account of the different forms of intentionality that allow the practical philosopher to decide to what degree intentionality is a necessary condition for autonomy. It is in this account that the role of the conscious self is central to single out those forms of intentionality that are indeed relevant for autonomy. The project argues that consciousness and control required for willing are at least in some form inseparable (for a criticism of epiphenomenal accounts of consciousness, see also Vierkant, 2002). Consciousness allows, according to the project, for a narrative owning of intentions which in turn is crucial for a sense of willing. The project here engages in a discussion with Proust's article 'Perceiving intentions' (2003, in Roessler, *Agency and self awareness*, 296-320).

Does the Will Exist? Willing Between Metaphysics and Pragmatism

While the first project is concerned with the practical side of a new understanding of voluntariness, the second philosophical project based in Munich investigates the ontological status of willing. It starts from the observation that different things can be meant when performances are characterized as being voluntary. Among them there are meanings the theoretical explications of which are controversial, whereas their applications to certain phenomena are not. It seems indisputable that we are able to try to act, to intend goals, to make choices, etc. However, the theoretical challenge lies in the task of analyzing these mental performances and in clarifying the relationship between speaking of these performances and other levels of description in order to determine their way of existence.

Yet, there are also (aspects of) concepts of voluntariness in which it is controversial whether they correspond to something in reality or not, and even more strongly whether they are consistent at all. Therefore, many thinkers deny that there could be willing in the sense of starting new causal chains without preceding sufficient motives and intentions. They judge a concept of unmotivated willing to be inconsistent because body movements, which are not brought about by motives, lack connection to the person such that she cannot count as the originator of the event and therefore such events would not be voluntary.

The theoretical framework suggested in this project is designed to integrate controversial structures like unmotivated willing, too. The approach draws attention to both what leads to a voluntary action (or trying to act) and to what the action (or trying) stands for within the actor's mental landscape and its surrounding social practice. The first component of the explanation is causalistic. The causal interpretation is needed because characterizing a performance as voluntary has a lot to do with the way the performance is brought about: The reasons/motives put forward by a rationalization have to play an effective role in the process of bringing about the performance. Similarly, more complex phenomena of voluntariness such as responsibility and autonomy depend on the fact that the reasons leading to action did not arise wrongfully, as, for instance, by manipulation. Nevertheless, the success of such a causal explanation is limited. This is because of the mental realm's specific nature as compared to the physical realm. It is the physical realm that is prototypical for causal-deterministic explanations. Mental states and processes are less definite, causal/genetic explanations are on principle incomplete. Even unconscious motives and intentions cannot sufficiently fill out all the gaps in a causal explanation of shaping one's will and acting. The difficulty of an analysis of this particular sphere results from the fact that some of its structures are neither directly accessible by introspection nor by physical measurement. One requirement for the approach of this project is for it to find a way to deal more satisfactorily with such fuzzy entities. To this end, occurrences of willing are represented as certain changes in the intentional/normative practice (decisions as commitments). In addition to the embedding of willing into the person's mental landscape, there is a (different) embedding of that landscape in a normative practice. So what makes a performance to be a voluntary action is not to be found inside the person's physiological boundaries alone.

Why not assume there is something like unmotivated willing?

That willing is to some extent to be analyzed in irreducible normative terms does not necessarily mean it doesn't really exist.

At this point considerations about how to analyze willing suggest an ontological perspective on the topic. To be real is often identified with causing effects or being caused. According to this view, willing in such aspects not characterized in terms of causation but of undertaken commitments and attributions does not really exist; rather, it is merely a subsequent construct that may be of relevance for practical purposes but is irrelevant for ontology. Whereas – after a discussion of concepts such as to really exist, to be a construct, or be an illusion – the project seeks to establish an ontology of entities that are not characterized by causal roles. Therefore, among other things, a concept of objectivity has to be developed that guarantees the possibility that all people participating in the social practice of ascribing intentional attitudes could err about a certain attribution of willing.

Maasen, S., Prinz, W., & Roth, G. (Eds.). (2003). *Voluntary action: Brains, minds, and sociality. Oxford, UK: Oxford University Press.*

Vierkant, T. (2002). Zombie-Mary and the Blue Banana: On the Compatibility of the 'Knowledge Argument' with the Argument from Modality. *Psyche: An Interdisciplinary Journal of Research on Consciousness, 8(19)* (from: http://psyche.cs.monash.edu.au/v8/psyche-8-19-vierkant.html).

Vierkant, T. (2003). *Is the self real? An investigation into the philosophical concept of 'self' between cognitive science and social construction.* Münster: LIT Verlag.

Section 5: Expertise and Acquisition of Action and Event Structures

Wolfgang Prinz, Ulrich Drost
Iring Koch, Martina Rieger, Peter Keller

Introduction
Research Questions

One important aspect of the relationships between cognition and action is that actions are performed to attain desired goals, hence, to intentionally produce particular events. These events may differ in their remoteness from the agent's body: An action can be performed to produce events in one's own body *(proximal action effects)*, like feeling one's arm move toward a light switch, or to produce events in the environment *(distal action effects)*, like seeing the light go on. Additionally, action goals may differ in complexity: Some action goals are simple, such as moving a finger to press a key, whereas others are rather complex and require the combination of several actions, such as driving a car.

By definition, an action goal can be attained only after the action has been completed. However, in voluntary action, a representation of the goal seems to be involved before the action starts, that is, at the early stages of action planning. This anticipatory representation of the action goal serves at least two functions: First, we plan and execute our actions such that they are likely to lead to the desired goal and, hence, an anticipatory goal representation is involved in *action control*. Second, after performing the action, we compare the attained goal with the desired goal and, hence, an anticipatory goal representation is involved in the *evaluation of action success*. Yet, both functions require the presence of a representation of the goal that controls the selection and execution of appropriate movement patterns. According to this logic, intentional action is controlled by some anticipatory representation of the intended and expected action effects. This idea is usually referred to as the "ideomotor principle".

From this perspective, performing goal-directed actions may become very difficult, because the relationships between actions and their effects tend to be rather complex: On the one hand, one action may lead to several different effects, whereas, on the other hand, one effect may be produced by several different actions. Thus, the cognitive system has to *learn* the contingencies between movements and effects in order to perform voluntary actions. Thus, the system learns to anticipate certain action effects when it performs certain movements. Then, anticipatory goal codes can be derived from the learned relationships and be used to control goal-directed actions.

Projects

The projects in this section deal with the issue of how the representations of action effects are acquired and how they are then used to control the selection of voluntary actions. The major common feature of the projects is the underlying idea that actions are triggered and controlled by anticipating their distal action effects. As we shall see, this "action-effect principle" helps to interpret data on (1) the control of simple, discrete actions, but also (2) action-effect compatibility, (3) the combination of simple actions into more complex sequences, and (4) motor-skill expertise.

The project **Acquisition of Action-Event Structures** shows how representations of action effects are acquired and how they are used to control simple, discrete actions. The underlying assumptions are incorporated into a two-stage model of action control. The general notion is that in Stage 1 of the model, given sufficient contingency, distal effects become associated with the movements that elicit them. Hence, actions are represented cognitively by codes providing information about the sensory effects a given motor program is likely to produce. Stage 2 refers to the selection of goal-directed movements. When the learned associations attain a certain strength, presentation of the action effects leads to an activation of the motor program assigned to the movement. Thus, movements can be selected by anticipating (i.e., activating the codes of) their consequences.

The project **Compatibility of Actions and Events** investigates how action production is affected by the degree to which features of a response correspond with features of its effect. One question is whether conceptual (e.g., semantic meaning) features as well as physical features (e.g., intensity) play a role in determining the degree of response-effect (R-E) compatibility. Our results suggest that conceptual features do play a potent role. Another theme of this project concerns the stage(s) of action production at which R-E compatibility effects are manifest: response selection, initiation, and/or execution. Results suggest that R-E compatibility can exert influence on all three stages of action production. A final issue was whether R-E compatibility effects extend to actions that comprise multiple movements, and we found clear evidence that they do.

The project **Sequencing Actions and Events** reveals that associations between movements and their effects also impede the learning of action sequences. This learning plays a central role in action control, as it allows people to predict upcoming events and to prepare corresponding responses. The major experimental paradigm for investigating sequence learning is the serial reaction-time (SRT) task (Figure 5.0.1). Usually, participants in an SRT task show practice-related improvement in performance, but they have no conscious recall of what they had learned before (implicit learning).

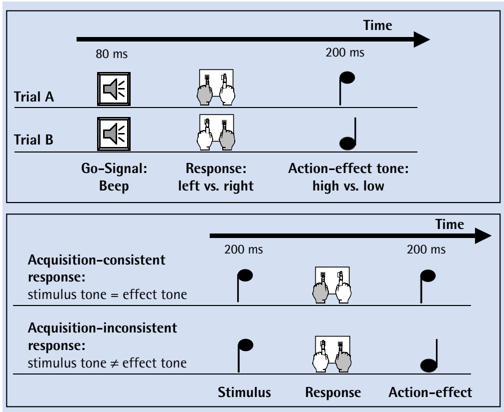

Figure 5.0.1 Experimental design testing the two-stage model. (Top) *Acquisition phase: Each keypress is consistently followed by a certain tone.* (Bottom) *Test phase: Action-effect tones are presented as imperative stimuli. Typically, acquisition-consistent responses are executed faster and selected more often than acquisition-inconsistent responses.*

One topic that has received much attention is whether sequence learning is mediated mainly by the perceptual or rather by the motor system. Although there is evidence that sequence learning is based on learning relations between the stimuli of the sequence (S-S learning), the results obtained in the second project imply that the structures of the response sequence (R-R learning) or those of both stimuli and responses (S-R or R-E learning) are also important for learning action sequences.

In the project **Expertise and Action Activation** the assumption that action effects and other action-relevant events can activate the corresponding actions is investigated in motor experts, that is, in musicians and people skilled in ten-finger typing. The action-effect principle requires the prior acquisition of integrated action-effect associations, the strength of which should depend on the amount of learning. Accordingly, results imply that these associations are evident in motor experts. Apart from action effects, action-relevant stimuli also have the power to activate the corresponding actions in motor experts. These mechanisms probably contribute to the high performance levels that can be achieved in motor skills.

5.1. Acquisition of Action-Event Structures

The Acquisition of Associations Between Action and their Perceivable Consequences

Birgit Elsner

Supported by the Deutsche Forschungsgemeinschaft (DFG SFB 462 Sensomotorik).

The main question of this project was how agents learn about the consequences of their actions and how acquired action-effect representations are used to select voluntary actions. Each experiment was divided into two phases. In a learning phase, participants performed left or right keypressing responses, and each keypress was contingently followed by a low or a high tone (see Figure 5.0.1, previous page). According to the two-stage model of voluntary action (Elsner & Hommel, 2001), the experience of several co-occurrences of a response and a tone should trigger an association between the cognitive representation of the movement and of the tone. If so, presenting the tone (e.g., the high tone) should prime the associated response (e.g., the left keypress). To investigate the mechanisms underlying action-effect acquisition, Elsner and Hommel (in press) varied factors known to affect associative instrumental learning. In the learning phase of Experiment 1, groups of participants experienced different temporal delays between keypresses and tones *(temporal contiguity)*, while Experiment 2, the covariation of keypresses and tones *(contingency)* was manipulated.

The impact of these manipulations was assessed in a test phase, which was the same for all participants. Here, the former action-effect tones were presented as imperative stimuli, and participants either had to perform each keypress after the tone that it had previously produced (acquisition-consistent mapping) or after the tone that had been produced by the alternative action (acquisition-inconsistent mapping). Results showed that response priming, as indicated by RT-differences between acquisition-consistent and -inconsistent test responses, was most pronounced (1) when action and effect were separated by less than two seconds in the learning phase (Figure 5.1.1), (2) when the effect only rarely occurred in the absence of the action, or (3) when the overall frequency of an effect was high. Thus, the frequent co-occurrence of an action and an effect is a critical factor for the acquisition of action-effect knowledge, and hence for the degree to which the planning and execution of future actions is affected by this knowledge.

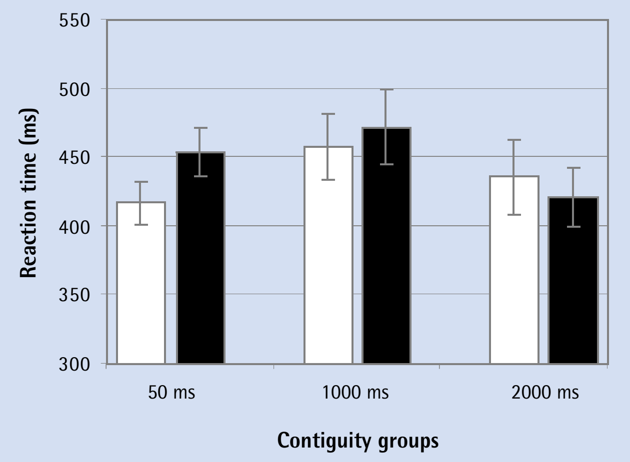

Figure 5.1.1: Mean RT and standard errors in the acquisition consistent and -inconsistent test blocks in three contiguity groups (delay between keypress and tone in the learning phase: 50, 1000, or 2000 ms).

The neural substrate linking the outcome of an action to the action itself was investigated in cooperation with H. R. Siebner (Klinikum rechts der Isar, Munich). For this purpose, healthy adults learned that keypresses were consistently followed by certain tones (Elsner, Hommel, Mentschel, Drzezga, Prinz, Conrad, et al., 2002). During H215O positron emission tomography (PET) imaging, participants listened to varied ratios of (response-related) action-effect tones and (not response-related) neutral tones without performing any movement. The caudal supplementary motor area (SMA) and the right hippocampus showed a graded increase in functional activation with the frequency of action-effect tones. The former activity most likely reflects "backward" activation of the keypress by the perception of the learned action effect, whereas the latter may represent the retrieval of learned action-effect associations from memory. Because these activations occurred in the absence of a movement, both brain areas seem to be involved in a flexible binding process that helps to promote the control of voluntary actions.

Elsner, B., & Hommel, B. (2001). Effect anticipation and action control. *Journal of Experimental Psychology: Human Perception & Performance, 27(1),* 229-240.

Elsner, B., & Hommel, B. (in press). Contiguity and contingency in action-effect learning. *Psychological Research.*

Elsner, B., Hommel, B., Mentschel, C., Drzezga, A., Prinz, W., Conrad, B., et al. (2002). Linking actions and their perceivable consequences in the human brain. *NeuroImage, 17(1),* 364-372.

5.2. Compatibility of Actions and Events

The Anticipation of Action Effects Guides Action Selection

Peter Keller
Iring Koch

In a project in cooperation with W. Kunde (University of Halle), we varied response-effect (R-E) compatibility (Koch & Kunde, 2002; Kunde, Koch, & Hoffmann, in press) to pursue the idea that effect representations guide action selection. In one experiment, participants vocalized a color word in response to a visually presented digit (Koch & Kunde, 2002). The vocal response resulted in the presentation of a visual response-effect which was either a color-word printed in congruent color or a string of colored non-word letters. The effect could be compatible or incompatible with the vocalized color-word. A clear compatibility effect was found (RTs were longer in the incompatible than in the compatible condition), suggesting that R-E compatibility pertains primarily to the abstract meaning of the effect-word, but much less on the color of the letters. This "conceptual" R-E compatibility effect extends previous findings in the spatial and intensity dimension (Kunde, 2001, *JEP:HPP, 27,* 387-94; Kunde, Koch, & Hoffmann, in press). Importantly, the compatibility effect is not produced by the physical response-effect itself, but rather by the anticipation of the response-effect.

Using a R-E compatibility manipulation on the intensity dimension, Kunde et al. (in press) showed that forceful responses are facilitated when a loud tone rather than a soft tone is anticipated as response effect, whereas this relation is reversed for less forceful responses. In one experiment, we found this R-E compatibility effect even when participants already prepared the (pre-cued) response, suggesting that the influence of anticipated response effects extends from action selection to action initiation and execution.

R-E compatibility is likely to play an important role in real-life activities such as music performance. Keller and Koch (subm.) investigated this issue using an experimental paradigm designed for testing musicians. The task involved responding as quickly as possible to each of four color-patch stimuli by producing a unique sequence of three taps on three vertically-aligned response plates (e.g., PINK = top, middle, bottom). Each tap on a different plate triggered a tone of distinct pitch. The compatibility between responses (taps) and effects (tones) was manipulated by varying the plate-to-pitch mapping. In a compatible condition, taps on the top, middle, and bottom plate triggered tones of high, medium, and low pitch, respectively. This plate-to-tone mapping was scrambled in an incompatible condition. We found that RTs (i.e., the time taken to lift the tapping finger from a home-key following stimulus onset) were longer for incompatible than for compatible mappings (see Figure 5.2.1). Thus, planning a sequence of actions with music-like auditory effects involves accessing a mental representation of the effects – the melody – more so than a representation of the movements themselves. Taken together, the above results are consistent with the ideomotor theory, which states that anticipated response effects automatically activate corresponding responses. We have shown that this holds for verbal and manual responses, and even extends to action sequence production (see also Section 5.3).

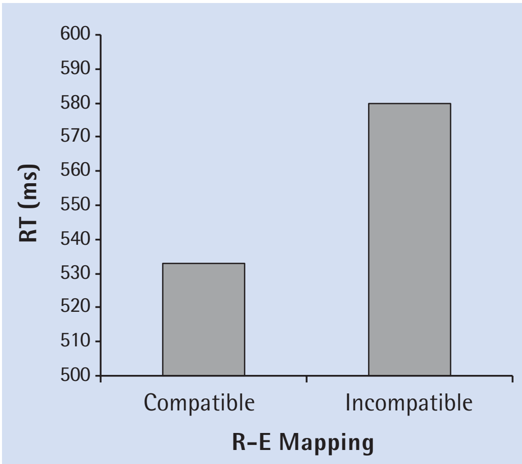

Figure 5.2.1: Mean RT as a function of R-E compatibility.

Keller, P. E., & Koch, I. (subm.). *Action planning in sequential skills: Relations to music performance.*

Koch, I., & Kunde, W. (2002). Verbal response-effect compatibility. *Memory & Cognition, 30(8),* 1297-1303.

Kunde, W., Koch, I., & Hoffmann, J. (in press). Anticipated action effects affect the selection, initiation and execution of actions. *The Quarterly Journal of Experimental Psychology. Section A: Human Experimental Psychology.*

5.3. Sequencing Actions and Events

Thomas Goschke
Iring Koch

This project investigates the learning of different kinds of sequences which underlies the ability to anticipate upcoming events (perceptual learning) and/or actions (motor learning).

Differentiating Perceptual and Motor Sequence Learning

In earlier experiments, we addressed the question whether learning is based on perceptual or motor learning, by manipulating the structure of stimulus and response sequences independently from each other (Koch & Hoffmann, 2000, *JEP:LMC, 26,* 863-82).

In a more recent experiment, we kept sequence structure constant and focused on the effect of response modality (verbal vs. manual) on sequence learning (Zirngibl & Koch, 2002). We found that sequence learning was facilitated with verbal responses as compared to manual responses. This facilitation of learning with verbal responses can be attributed to differences in response-effect distinctiveness, because (apart from distinct proprioceptive feedback) each verbal response produces a distinct auditory effect that enriches the response sequences, whereas manual responses only produce a nondistinct and uniform sequence of clicks of the keyboard. Finding facilitated learning with verbal responses clearly suggests that anticipation of response effects is important for sequence learning.

Acquisition of Spatial and Nonspatial Sequences

In a collaborative project with the MPI of Cognitive Neuroscience (Leipzig) we investigated whether *spatial response and nonspatial stimulus* sequences are learnt independently (Goschke, Friederici, Kotz, & van Kampen, 2001). In a *serial search task*, on each trial four letters were presented (e.g., DACB), followed by an auditory target letter (e.g., B). Participants signaled the location of the target letter in the visual array by pressing one of four response keys. The array of visual letters was changed from trial to trial such that either the sequence of target locations and key-presses followed a repeating pattern (while the phoneme sequence was random), or the sequence of phonemes followed a repeating pattern (while the sequence of target locations and key-presses was random). A group of healthy control participants learnt both the location and the phoneme sequences, as indicated by the fact that for both kinds of sequences RTs increased reliably when the repeating sequence was switched to a random sequence (Figure 5.3.1, right panel). In contrast, a group of patients with left-frontal lesions suffering from Broca's aphasia showed intact learning of the location-response sequence, but was selectively impaired in acquiring the phoneme sequences, presumably due to an impaired phonological working memory (Figure 5.3.1, left panel). This dissociation suggests that partially separable brain systems are involved in procedural learning of spatio-motor and phoneme sequences.

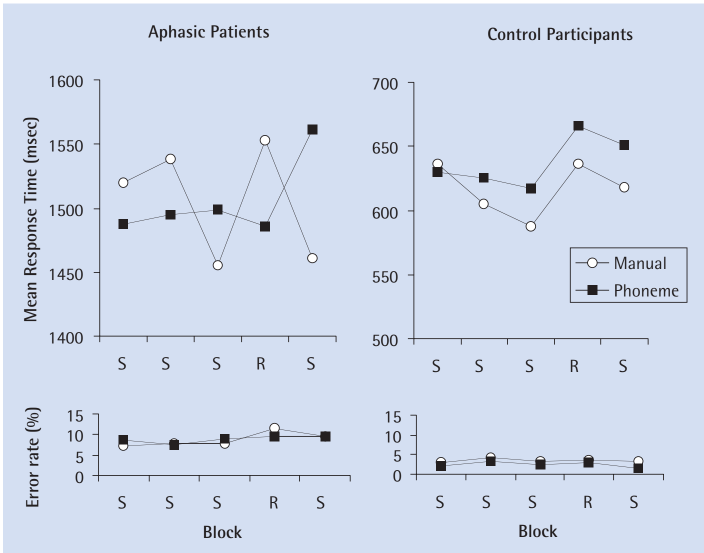

Figure 5.3.1: Mean RT and error rates in the serial search task for Broca's aphasics and age-matched control participants for the manual key-press sequence and the auditory phoneme sequence. S = Structured sequence; R = Random sequence.

Supported by the Leibniz Science Prize awarded to Angela D. Friederici by the Deutsche Forschungsgemeinschaft (DFG) and by grant GO 720/1-2 of the DFG.

Goschke, T., Friederici, A.D., van Kampen, A. & Kotz, S.A. (2001). Procedural learning in Broca's aphasia: Dissociation between the acquisition of spatio-motor and phoneme sequences. *Journal of Cognitive Neuroscience, 13(3),* 370-388.

Zirngibl, C., & Koch, I. (2002). The impact of response mode on implicit and explicit sequence learning. *Experimental Psychology, 49(2),* 153-162.

5.4. Expertise and Action Activation

Ulrich Drost
Martina Rieger

In this project we investigate whether action effects and other action-relevant events can activate the corresponding actions in motor experts.

Event Representations in Musicians

In these experiments, which are run in collaboration with M. Braß and T. Gunter from the MPI of Cognitive Neuroscience at Leipzig, we examined action-effect structures in experienced musicians. In a first series, we studied whether action-effect (A-E) associations are present in experienced pianists, as compared to non-musicians, and whether these associations involve *motor* and/or *conceptual* representations (Drost, Rieger, Braß, Gunter, & Prinz, subm.). Participants played chords on a keyboard in response to imperative visual stimuli. Concurrently with each imperative stimulus, a task-irrelevant auditory chord stimulus (piano sound) was presented, which could be either congruent or incongruent with the chord to be played. Response times of piano experts were slower in the incongruent than in the congruent condition (interference effect), whereas non-musicians showed no difference. In further experiments with experts, by varying stimulus and response types, we showed that the interference can occur on both motor and conceptual levels. Thus, A-E associations are present in experienced musicians. These associations are not simple sensorimotor connections, but also involve "higher" conceptual levels of representation.

In a second set of experiments, we investigated whether A-E associations in musicians are learned specifically for their own instrument, or whether they generalize to other instruments. The task of playing chords was the same as described above. Irrelevant auditory stimuli were presented in five types of instrument timbres: piano, organ, guitar, flute, and voice. For pianists we obtained an interference effect in the piano and the organ condition only, whereas for guitarists an effect was obtained in the guitar condition only (see Figure 5.4.1). Thus, A-E associations seem to be specific for one's own instrument. However, on a conceptual level, "alien" instrument sounds may also be able to activate action-relevant representations.

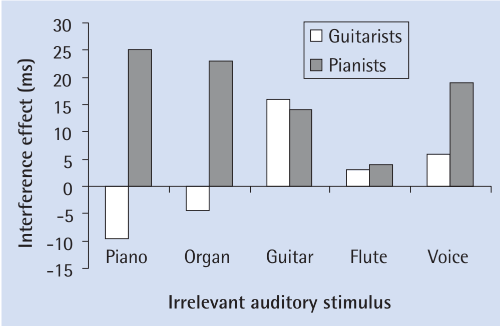

Figure 5.4.1: Interference effect for different irrelevant auditory stimuli in pianists and guitarists.

Action Activation in Skilled Typing

In this project it was investigated whether seeing letters activates the corresponding action of key-pressing in people skilled in typewriting with the ten-finger-system (Rieger, in press). Participants responded to the color of letters (congruent condition: responding finger was the one usually used to type the letter presented). Skilled participants showed a congruency effect, unskilled participants did not. The size of the congruency effect depended on the similarity of the movement required in the experiment to that usually performed in typing. Responding with crossed hands on an external response device provided evidence for effector-dependent representations only, whereas responding on a keyboard resulted in evidence for effector-dependent and spatial representations (see Figure 5.4.2).

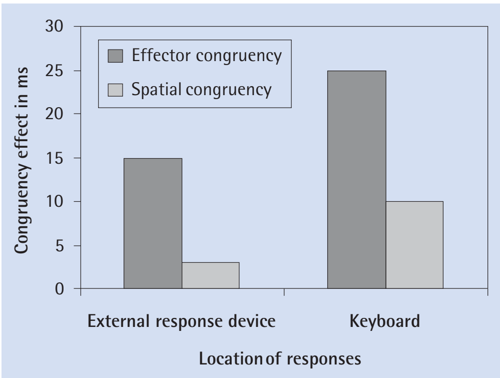

Figure 5.4.2: Effector and spatial congruency effects for responses on an external response device and on a keyboard in participants skilled in typing with the ten-finger system.

Drost, U., Rieger, M., Braß, M., Gunter, T., & Prinz, W. (subm.). *Potential action effects evoke conceptual and motor-related representations in pianists.*

Rieger, M. (in press). Automatic keypress activation in skilled typing. *Journal of Experimental Psychology: Human Perception and Performance.*

Research Units

Page

1. Infant Cognition and Action

The research group "Infant Cognition and Action" investigates the early development of the cognitive mechanisms of action perception and action control. The main aims of the unit are (1) to analyze the cognitive aspects of infant action control and how they develop, (2) to study the development of infant understanding of actions performed by other persons, and (3) to investigate how these two aspects of action control interrelate during early development. The theoretical approach research in this unit is based on is the common-coding theory; thus, special emphasis is given to the role of action effects in infant action perception and action control.

Annette Klein, Tanja Hofer
Petra Hauf, Gisa Aschersleben

Gisa Aschersleben (head)
Birgit Elsner
Petra Hauf
Tanja Hofer
Bianca Jovanovic
Annette Klein

Background

To study action control and action understanding a clear definition is required of what constitutes an action – as opposed to, for example, a movement. Actions differ from movements in their intentional character, that is, actions are directed towards goals. As a consequence, it is important for both theoretical considerations and practical experimental planning to distinguish the two constituents of an action: the movement and the goal. This distinction corresponds to the well-established distinction between means and ends. One important consequence for investigating the questions outlined above is that infants have to be able to differentiate means from ends, and they need this discrimination not only to interpret the actions they see as being directed towards goals, but also to perform their own goal-directed actions. In infant research, we were the first to suggest that these action goals correspond to action effects, and that they play a crucial role in both action production and action perception.

The assumption that action-related effects play an important role in action control is based on considerations developed in the *Cognition & Action Group* – the common-coding approach. Its core postulation is that perceived and to-be-produced events are represented in a common domain in which both actions and events are represented in an abstract format. As a consequence, codes of both types (perceived events and to-be-produced actions) can communicate with each other directly with no need for a translation process to mediate between the perceptual and the motor side. During the last decade, the group has gathered a great deal of evidence supporting such a general framework (for an overview, see Hommel, Müsseler, Aschersleben, & Prinz, 2001). One central aspect of the account is that the format of these codes is a distal one. That is, actions are represented in terms of the distal effects they produce in the world and not, for example, in terms of muscular innervation patterns. These action-generated effects include effects at several levels such as body-related afferent information, visual information about, say, the position of the arm during and/or after a movement, and the resulting auditory pattern.

The general approach underlying the projects in this unit is additionally motivated by extensive empirical support for the idea that actions are controlled by their anticipated distal effects. Two aspects frame our approach: First, we assume that action-generated effects play an important role not only in adults' but also in infants' action control. To validate this assumption, in a number of projects, we demonstrated an influence of action-generated effects on how infants control their own actions and, moreover, on how they interpret actions performed by other persons. Second, we assume an abstract representation of events, which allows us to draw some interesting conclusions about the relation between the two aspects of action control we focus on – active performance and the interpretation of other persons' actions. In principle, three conclusions are possible:

1) The traditional view already proposed by Descartes is based on the assumption that people have privileged access to first-person knowledge, whereas knowledge about other persons is mediated and transformed via perception. Thus, most infant researchers assume that infants understand themselves first – in our case, infants understand that they are able to produce goal-directed actions, and this understanding is based on personal experience; and it is only then that they are able to transfer this knowledge to an understanding of actions performed by others.

2) The second view assumes the reverse: Infants first understand other people - and that people in the outer world perform goal-directed actions - and it is only then that they are able to transfer this knowledge in order to understand themselves and perform goal-directed actions. One in no way trivial precondition for this view is that the representation of knowledge about *me* does not differ from the way knowledge about other persons *(you)* is represented.

3) A third view postulates that action perception and action production are based on the same codes at a representational level. Like the second view, this view also presupposes that the representation of knowledge about *me* is similar to the representation of knowledge about *you*. The concrete assumption would then be that even very young infants have an abstract representation of actions in terms of action-generated effects, and that this representation is used by both the motor system (to perform goal-directed actions) and the perceptual system (to interpret observed actions as goal-directed). Developmental differences at the age at which one might observe the ability of infants to either perceive or perform goal-directed actions would then be based on developmental limitations of the perceptual and the motor system.

The projects in our unit aim at gathering empirical support for this third view, because it is a direct deduction from the common-coding approach. However, this view does not answer the question when and how these abstract representations emerge and whether experience with both action perception and action production is necessary for the abstract representations to be established. We assume that these representations develop very early in infancy, that is, during the first two or three months of life. At this age, infants produce a great amount of movements with their head and their legs and arms, which (at least most of them) do not seem to be goal-directed. During this phase, infants perceive and learn contingencies between their movements and the effects they produce (in both their body and the world, e.g., proprioceptive, tactile, visual, and auditory). Finally, after two or three months, abstract representations of these action-generated effects have been established that allow the infants to control their actions in terms of their anticipated effects. Thus, we assume that these representations need input from both the perceptual and the motor system in order to develop.

Our projects mainly serve to demonstrate the important role of action-generated effects in infants' perception of goal-directed actions and in self-performed actions. As a consequence, we study preverbal infants (i.e., those aged approximately 6-18 months). The methods applied have to suit this age group, so that we mainly use the habituation paradigm, the preferential-looking, and the imitation paradigm (see next paragraph).

Methods

The typical way to collect data in preverbal infants is through observing their behavior, for example, looking-behavior or imitative behavior. One classical method in infant research is the *habituation paradigm*. When infants are presented with the same object or sequence of actions repeatedly, they lose interest and looking time decreases. On the other hand, if they are presented with new objects or actions, looking time increases. This pattern can be used to examine which features of an object or an action sequence are perceived as differing from those the infant is habituated to. Another classical method that also relies on measuring infants' looking behavior is the *preferential-looking paradigm*. Here, infants are presented with, say, two different objects (either at the same time or in succession), and looking times are analyzed. If the infant looks at each of the two objects in a different way, this behavior is interpreted as evidence that the infant is able to perceive the difference between them. A third method that we have employed relies on infant's imitation behavior. In the *imitation paradigm*, a sequence of actions (e.g., object manipulation) is demonstrated in front of the infant. Then, either right afterwards or after a delay the object is handed over to the infant to see whether he or she produces the demonstrated action sequence more often than infants in a control condition who were not exposed to the actions.

Figure 1: Experimental set-up for preferential looking studies.

Project Area: Infants' Perception of Goal-Directed Actions

Actions Performed by a Human Agent

To study infants' perception of goal-directedness in other persons' actions we applied the habituation paradigm. Woodward (1998, *Cognition, 69,* 1-34; 1999, *Infant Behav Dev, 22,* 145-60) demonstrated that 6-month-old infants pay more attention to changes in the goal objects of grasping actions than to changes in the motion path. She interpreted this finding in terms of an early sensitivity to action goals. Nevertheless, when infants were presented with a *nonpurposeful* action – a hand falling backwards onto one of two objects – there were no signs of the distinctive looking pattern described above, neither at the age of 6 months nor at 9 months. According to the author, this is evidence for an early capacity to distinguish between purposeful and nonpurposeful actions. However, this finding has been criticized, because Woodward was only able to demonstrate the effect with grasping.

Part of the Project Area Infants' Perception of Goal-Directed Actions *was conducted in collaboration with György Gergely, Hungarian Academy of Sciences, Budapest.*

Using this paradigm, we tested the hypothesis that a salient action effect is an important feature for young infants to interpret actions as goal-directed. We argue that infants are probably quite familiar with the grasping motion and its consequences, namely, object manipulation. It might then be this expectation of object manipulation that makes infants encode the target object in a specific way. In contrast, the unfamiliar nonpurposeful action is less likely to be associated with object-directed effects. Following this rationale, the introduction of an action effect after the same nonpurposeful action should transform this into a goal-directed action and produce similar results as in the grasping study. Consequently, we modified Woodward's nonpurposeful condition by adding to it an effect. The study was conducted with 6-month-old infants who were habituated to an action sequence in which a hand was lowered onto an object and then pushed it towards the rear end of the stage. As predicted, under these conditions, infants behaved in a similar manner as in the grasping study: They recovered attention after habituation more strongly when the target object was changed than when the motion path was altered. Results of a control condition, in which the infants were shown a grasping hand that carried the object to the back of the stage indicated a similar effect. Thus, the results support the notion that action effects play an important role for infants' interpretation of actions as goal-directed (Jovanovic, Király, Elsner, Gergely, Prinz, & Aschersleben, subm.; Király, Jovanovic, Prinz, Aschersleben, & Gergely, 2003).

Actions Performed by a Mechanical Agent

In a follow-up study, the grasping hand was replaced by a mechanical claw. In the original study, Woodward (1998, *Cognition,* 69, 1-34) did not find goal attribution in 6-month-olds if the grasping action was performed by a mechanical claw. Similarly, there were no significant differences between test conditions, even when the action was followed by a salient action effect (object displacement; Jovanovic et al., subm.) indicating that young infants' action interpretation distinguishes a human from a nonhuman agent. Moreover, it suggests that infants' attribution of goal-directedness is preferentially applied to human agents – at least at the age of 6 months, and that nonhuman entities are treated differently, regardless of whether the action brings about changes in the environment or not.

Further studies tested the hypothesis that at the end of the first year infants interpret movements of a mechanical claw as goal-directed. In addition, we expected the salience of the action effect to play a crucial role. Due to a higher level of experience, 6-month-old infants might be more familiar with actions performed by human agents than by mechanical agents (e.g., tools, machines), whereas older infants may already interpret rational

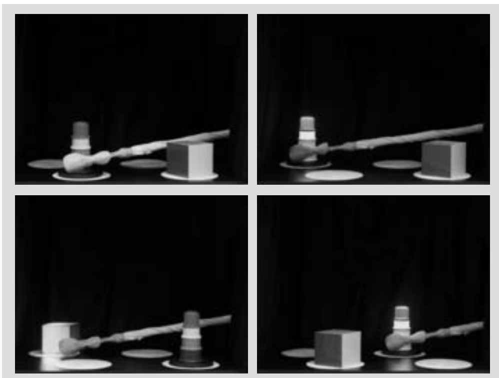

Figure 2: Experimental setup used in the Project Area Infants' Perception of Goal-Directed Actions. *The conditions with a mechanical agent and highly salient action effects are depicted. Upper row: Habituation event: A mechanical claw grasps one object and carries it to the back of the stage. Lower row: Two test conditions: The positions of the objects are exchanged and the mechanical claw either grasps the new object via the old path (left panel) or the old object via a new path (right panel) and takes it to the back of the stage (Hofer, Hauf, & Aschersleben, subm.).*

actions of mechanical agents as goal-directed. Our studies with 9- and 12-month-old infants (using the same setup as Jovanovic et al., subm.) indicated that only 12-month-olds paid more attention to changes in the goal object of an action performed by a mechanical claw when it is followed by an effect. Finally, in a third study the salience of the action-effect was manipulated. Nine-month-old infants were presented with same set-up; however, at the end of the movement the goal-object lit up (see Figure 2). Indeed, 9-month-olds focused more on the goals of a grasping mechanical claw if the action led to a highly salient effect. In sum, these findings indicate that the encoding of goal-directed actions performed by a mechanical agent is age-related and develops at the end of the first year. Further, we found additional support for the assumption that salient action effects enhance the understanding of action goals in infancy (Hofer, Hauf, & Aschersleben, subm.).

Project Area:

Learning about the Effects of Observed Actions in Infancy

Little is known about what infants learn from observing other persons' actions. However, there is evidence that they begin to understand the goal-directedness of others' actions from around six months of age (see Project Area *Infants' Perception of Goal-Directed Actions*) and that infants as young as two months can learn the consequences of their own actions. This project investigated (1) whether they learn about the effects of other persons' actions like they do for their own actions, and (2) whether infants expect their own actions to produce the same effect as others' actions. Infants explored an object that allowed two target actions, this producing a certain effect after each action. In a self-exploration group, 9-, 12-, 15-, and 18-month-olds explored the object directly. In two observation groups, infants first watched an adult perform the target actions and produce the effects, before exploring the object by themselves. In one observation group, the infants' actions brought about the same effects as the model's actions, while in the other group, the action-effect mapping for the infant was reversed as compared to that of the model. Results showed that observing the model affected infants' exploration behavior from 12 months, but not earlier, and that the specific relations between observed actions and

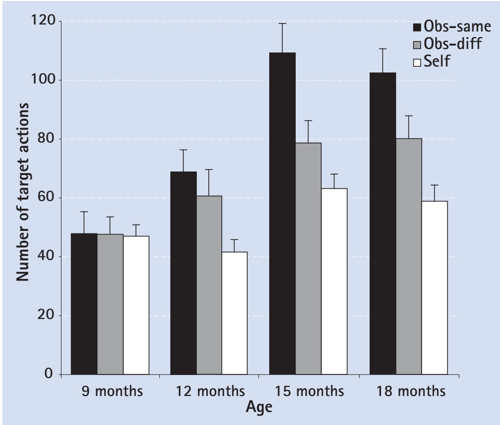

Figure 3: Findings of Elsner & Aschersleben (2003). Mean number of performed target actions for the four age samples (9, 12, 15, and 18 months), and the three experimental groups (Self, Obs-same, and Obs-diff) *in the exploration phase.* Self*: Self-exploration group,* Obs-same*: Infants watched an adult performing the target actions with the same action-effect mapping, and* Obs-diff*: The action-effect mapping for the infant was reversed.*

their effects were acquired by 15 months (see Figure 3). Thus, around their first birthday infants learn the effects of other persons' actions by observation, and they transfer the observed action-effect relations to their own actions in the second year of life (Elsner & Aschersleben, 2003).

Project Area:

Interaction Between Self- and Other-Performed Actions

This project area studies the question whether or not infants come to understand other person's actions *after and because* they understand their own actions – or whether the reverse is true and they understand their own actions *after and because* they have understood others. We first had to develop a new methodology, which allows to study within the same paradigm both the infant's own actions and infant's perception of other persons' actions. First pilot studies that applied different versions of the imitation paradigm indicated that they were not appropriate for younger infants. Thus, we developed a completely new paradigm using the preferential-looking technique. Infants at the age of 7, 9, and 11 months were randomly assigned to one of two experimental groups. (1) In the *other-condition* infants first watched a short video clip, which showed two adults playing with a toy. Person A acted on the toy, whereas Person B observed that action and repeated it immediately. This sequence was presented several times. Afterwards, the infant was allowed to play with two toys – the toy shown on the video and a new one. (2) In the *self-condition* the infant first played with one toy and then saw two video clips simultaneously. In both movies, the same two adults played with either the same or a novel toy (see Figure 4). In both conditions, 7-month-old infants showed no significant differences between their looking and playing time for the novel and the same toy. That is, the perception of other person's actions had no influence on the infant's own active action performance or vice versa. However, at the age of 9 and 11 months, the perception of other persons' actions was significantly influenced by the previous active performance (longer looking and playing time for the same toy in the self-condition, but no differences in the other-condition). These results support the idea that infants understand other persons' actions *after and because* they have understood their own actions (Hauf & Aschersleben, subm.).

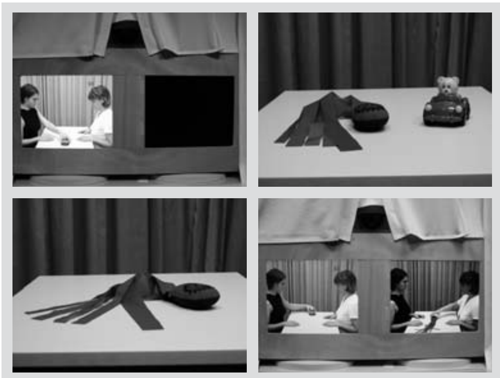

Figure 4: Interaction between self and other-performed actions: Experimental setup. Upper row: Other-condition: *Infants first watched a video clip and then had the choice to play with either the same toy or a novel one. Lower row:* Self-condition: *Infants first played with a toy and then watched two video clips simultaneously, showing two adults playing with either the same toy or a novel one.*

Project Area:

Action Effects in Action Control

Whereas there is ample evidence that, in adults, the selection and the planning of actions are clearly influenced by the anticipation of desired action effects, the role of action effects in infant action control is still an unsolved question. The studies in the present project area investigate this issue with different age groups using various experimental procedures.

Action Effects at the End State of an Action Sequence

In this project we investigated 9-, 12-, and 15-month-olds' ability to imitate a three-step action sequence. Infants in a demonstration group watched an adult perform three action steps that were causally related and led to a final action effect. The sequence was modeled three times, and after a 10-min delay the test objects were handed over to the infant. In each age group, these infants performed more target actions and took less time to the first action than infants in a control group, who only watched the initial and end state of the sequence, and infants in a baseline group who did not see any modeling. In detail, the 9-month-olds only imitated the first step in all groups indicating a general problem with the second step rather than a memory problem. Twelve-month-olds imitated the first two steps of the sequence, and by 15 months half of the infants also performed the third step. Thus, our target-action sequence leading to a clear action effect resulted in an increased number of performed target actions as compared to what has been reported in previous literature. This corroborates our assumption that action effects play an important role in young infants' action control (Elsner, Hauf, & Aschersleben, subm.).

Action Effects Following Different Action Steps

To test whether infants control their actions by anticipating action effects, just as adults do, we applied a three-step action sequence, in which either the second or the third action step was followed by a salient action effect. In an imitation paradigm, 12- and 18-month-old infants first observed an adult demonstrate the action sequence (1^{st} step: take a cylinder; 2^{nd} step: shake it; 3^{rd} step: return it; see Figure 5). In three experimental groups, either none, the second, or the third action step elicited an acoustical action effect. In a subsequent test phase, it was coded how often the infants performed each of the target actions. In both age groups, the action step that elicited an action effect was not only produced more often, but also occurred with lower latency. These results support the notion that infants control their actions by anticipating desired action effects (Hauf, Elsner, & Aschersleben, in press).

The Role of Action Effects in the First Year of Life

To extend on the findings about the role of action effects in action control in even younger infants we used an experimental setup, a two-button box, which required infants to press a button instead of grasping an object.

There were two one-step-actions (pressing the red or the blue button) each resulting in a similar effect (illumination and sound). In the demonstration phase, an experimenter pressed one of the two buttons three times (e.g., the red one) and, subsequently, pressed the other button three times (e.g., the blue one). Depending on the experimental condition, either one of the two actions or none resulted in an action effect. Preliminary results indicate that the latency to first touch did not differ between age groups (9-, and 11-month-olds) and conditions indicating that the applied experimental setup was suitable for the investigated age groups. The 9- and 11-month-olds performed the target action that caused salient action effects not only longer, but also with lower latency. These results indicate the influence of action effect anticipation on action control in the first year of life.

Another approach to study the role of action effects in younger infants is to apply a looking paradigm as this does not require the infant to perform any manual action. Infants at the age of 9 and 12 months were presented with short video clips showing the same action sequence that was presented live in the project *Action Effects Following Different Action Steps*. Thus, in the familiarization phase they saw a video with a person performing a three-step action sequence on a toy bear. Again, it was manipulated whether the second or the third action step was followed by an acoustical effect. In subsequent test trials the infants saw video clips in which either the same or the other action step (compared with the familiarization phase) was followed by the effect (familiar vs. unfamiliar test trials). Preliminary data indicate differences in looking time between familiar and unfamiliar test trials confirming that infants are not only interested in action effects as such but understand the link between action steps and their effects.

Further Projects

Influence of Haptic Experience on Visual Perception of Physical Events

It is known that 12-month-old infants are capable of haptically perceiving the property of weight. Further, they are able to recognize that an L-shaped box is adequately supported when its vertical not its horizontal portion rests on a platform. They seem surprised, however, if the box does not fall off in the latter case. Although this implies that infants perceive large as heavy and small as light, this relation has not yet been investigated directly. In our study, 12-month-olds first haptically experienced cylinders of different size and weight combinations (e.g., small/light and large/heavy vs. small/heavy and large/light). Afterwards, infants watched video clips with an adult placing a small and a large cylinder simultaneously on a balance. Depending on the condition, either the small or the large cylinder went down on the balance. We expect differences in looking time depending on the previous haptic experience.

Figure 5: Experimental set-up applied in Hauf, Elsner, & Aschersleben (in press).

The Project Influence of Haptical Experience on Visual Perception of Physical Events *was conducted in collaboration with Viktor Sarris, Institute of Psychology, University of Frankfurt/M.*

Retroactive Interferences in 18-Month-Old Infants

Retroactive interference is a well-known phenomenon in adults and older children. However, the typical test material (lists of words) and methods (verbal recognition and recall tasks) are not suitable for preverbal infants. Thus, we developed a new methodology to investigate the phenomenon in infants. Using a touch screen the infants first learned a list of pictures (car, ball, doll). Next, infants performed a distracting task, which was to learn either a list of related pictures (large-interference condition: another car, balloon, toy bear;) or a list of unrelated pictures (small-interference condition: rabbit, goat, duck). In the test phase, the infant had to detect the pictures, presented previously in the learning phase, among pairs of images. With increasing interference we expect an increase in the number of errors and in reaction time.

The Project Retroactive Interferences in 18-Month-Old Infants *was conducted in collaboration with Karl-Heinz Bäuml, Institute of Experimental Psychology, University of Regensburg.*

Elsner, B., & Aschersleben, G. (2003). Do I get what you get? Learning about effects of self-performed and observed actions in infants. *Consciousness & Cognition, 12(4),* 733-752.

Elsner, B., Hauf, P., & Aschersleben, G. (subm.). *Infants' imitation of action sequences: Only a memory problem?*

Hauf, P., Elsner, B., & Aschersleben, G. (in press). The role of action effects in infants' action control. *Psychological Research.*

Hauf, P., & Aschersleben, G. (subm.). *The influence of action production on action perception in infancy.*

Hofer, T., Hauf, P., & Aschersleben, G. (subm.). *Infant's perception of goal-directed actions performed by a mechanical agent.*

Jovanovic, B., Kiràly, I., Elsner, B., Gergely, G., Prinz, W., & Aschersleben, G. (subm.). *The role of effects for infant's perception of action goals.*

Kiràly, I., Jovanovic, B., Prinz, W., Aschersleben, G., & Gergely, G. (2003). Perceptual preconditions and generality of teleological understanding of intentional actions in early infancy. *Consciousness & Cognition, 12(4),* 753-770.

2. Cognitive Psychophysiology of Action

Processing spatial information in both the perceptual and the motor domain is essential for efficient behavior. By means of event-related EEG-activity, the information processing between stimuli and responses can be measured with high temporal resolution. Thus, the interaction between perception and action can be studied more accurately. Two main streams of research are reported here: (1) Studies on mechanisms of visual localization, and (2) investigations about the mechanisms involved in transferring spatial information into manual responses. To this end, the influence of different types of spatial information upon behavior was investigated (the dynamics of their influence upon behavior and the possible mechanisms involved).

Maren Wolber, Katrin Wiegand, Edmund Wascher, Selina Wriessnegger
Monika Kiss, Ivonne Buhlmann, Andrea Schankin

Edmund Wascher (head)
Ivonne Buhlmann
Monika Kiss
Andrea Schankin
Katrin Wiegand
Maren Wolber
Selina Wriessnegger

Methods: Laboratory Equipment

Our main laboratory is equipped with two 32-channel DC amplifiers. Visual stimuli are presented on a 22"-computer monitor driven by a VSG graphic accelerator. Participants are seated in an armchair in a sound-proof, dimly lit cabin. The chair can be adjusted individually in height in order to equalize the vertical visual angle and body position across participants. From outside the cabin the experimenter watches online displays of ongoing EEG, response statistics, and a video camera observing participants' gross movements. A second lab with a single 32-channel AC amplifier serves to develop experimental setups. Equipment for visual presentation is the same as in the main lab.

Project Area:

Deriving Spatial Information from a Visual Display

The designated aim of cognitive science is to understand information processing between input variables and observable behavior. On a perceptual level, the localization of visual information is a core function in visuo-motor transformation. If participants intend to grasp an object, they need to know where the object is located. Reliable measures of visual localization might help to uncover the role of visuo-spatial processing for behavior. Therefore, in a number of visual tasks event-related potentials (ERPs) of the EEG were investigated to evaluate measures that enable the segmentation of the stream of information processing between input and output.

Apart from well-known components of visual attention (P1, N1), asymmetrical ERP components were addressed. The latter components are based on the fact that many functions related to response and stimulus processing are organized contralaterally in the brain. This results in increased negativity over brain areas contralateral to a relevant stimulus or to an intended response. In detail, detecting a stimulus results in a phasic increase of EEG-activity contralateral to the location of the stimulus, the so-called PCN (= posterior contralateral negativity).

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Visual Attention

In a number of visual search tasks, we demonstrated that PCN latencies reflect differences in processing strategies between efficient and inefficient search tasks (Wolber & Wascher, 2003). Further, the relative salience of the target item (measured as the Mahalanobis-Distance) determined the set size effects on PCN latency as well as on RT in color- or form-singleton search. In inefficient search, PCN latencies increased with the number of distractors in the search array. Although PCN latencies correlated on a high level with RT under complex search conditions (conjunction search, search for less salient color- or form-singletons), RTs increased much faster with the number of distractors than PCN latencies. These data indicated that the process reflected in PCN was not sufficient to perform the task, but that the PCN is an index of an initial process – most likely the localization of a salience signal. This initial process does not terminate the search process in inefficient search tasks, but another process also depending on display size seems to be necessary for the response to be released. In addition, targets in the inefficient search condition that could not be detected did not release a PCN.

In search tasks with highly salient targets, PCN latencies were also related linearly to behavior. Moreover, the slopes of regression lines that relate RT and PCN latency were close to 1. The same pattern was observed with attentional cueing. In this paradigm simple stimulus detection was sufficient to give a reliable response. Thus, in visual tasks which can be processed based on automatic stimulus detection, the PCN reflects instantaneous target localization. In tasks like these, this process was sufficient to release a response (Wolber & Wascher, subm.).

In sum, these experiments present evidence that EEG asymmetries are a reliable measure of the timing of localization processing in visual tasks.

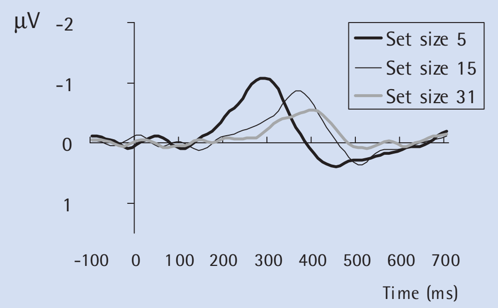

Figure 1: Exemplary PCN wave shapes at PO7/PO8 for a conjunction search condition to illustrate the observed set size effect on the PCN latency.

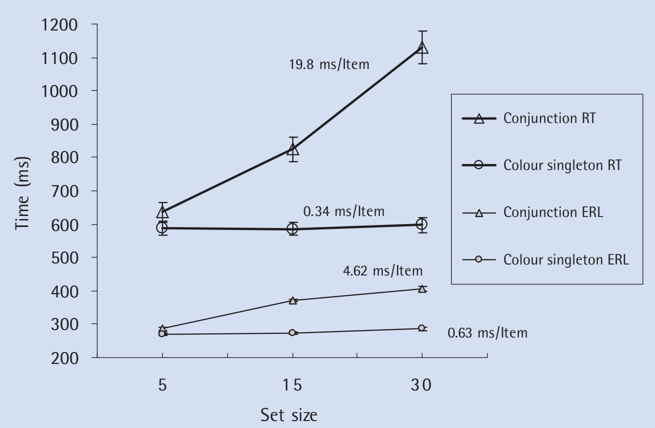

Figure 2: Mean RTs and PCN latencies as a function of set size for target present trials. Numbers represent slopes of RT by set size functions. For inefficient search not only PCN latency and RT data but also the time between PCN latency and RT increased with set size, indicating that the attentional process reflected by the PCN was not sufficient to release a response.

Results of further experiments suggested that this measure is related to conscious stimulus localization. Two experiments investigated the role of the PCN in a change-blindness paradigm. This phenomenon occurs if two successive displays differing in a detail are interrupted by a short blank. It is assumed that changes can only be detected if attention is directed to the location of the change. Accordingly, change-detection rate decreased with increasing distance of a change from the attentional focus. In these tasks, the PCN was observed only if participants detected and reported the change.

In cooperation with Kevin O'Regan (Institut de Psychologie, Centre Universitaire de Boulogne, Paris, France).

The assumption that the PCN possibly reflects a correlate of aware representation found further support in the results of two visual-masking experiments. ERPs were recorded during visual localization and discrimination of stimuli that were visually masked and therefore presented close to perceptual threshold. In both experiments, PCN varied in amplitude and duration in relation to the visibility of visual information. At short SOAs

(= stimulus onset asynchrony between target and masking stimulus), when participants performed at chance level, only short and transient asymmetrical ERP-activity was observed. However, when the SOA between stimulus and mask increased and thus target visibility, the PCN was larger and lasted markedly longer. We assume that the second peak of the PCN may reflect a process necessary for conscious perception, a process that directs attention to the stimulus. The data provide evidence for theories that claim that re-entrant processing of visual input from higher areas back to primary visual areas is necessary for awareness. Thus, the absence of the PCN with undetected or unidentifiable stimuli may reflect the lack of late re-entrant activity.

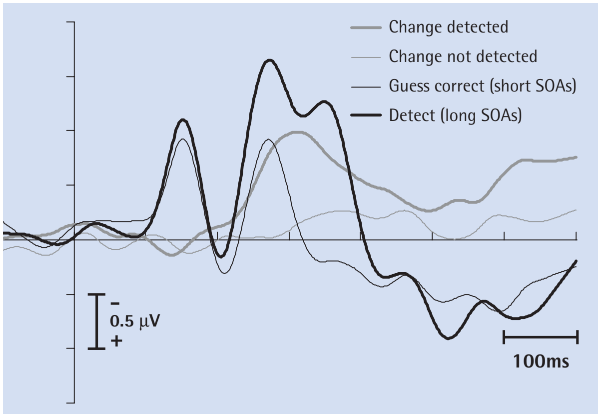

Figure 3: Grand average PCN for two experiments (change blindness and masking) at electrode position P07/P08. Sustained PCN activity is visible only in conditions, in which the stimuli could have been consciously detected. The longer latencies of the PCN might reflect a re-entrant process of the visual input from higher visual areas back to the primary visual cortex which is necessary for awareness.

Mechanisms of Visual Selection

Extracting required information from cluttered scenes involves directing attention to objects of interest as well as filtering out irrelevant information. Several inhibitory mechanisms have been proposed that prevent attention from returning to already rejected distractors, thus facilitating orientation towards novel locations. In particular, irrelevant information which has been previewed appears to be excluded from subsequent search.

Thus, performance in a difficult search task can be improved by introducing a short delay between one set of distractors and the remaining items, containing the target if present. To account for this finding, Watson and Humphreys (1997, *Psych Rev, 104,* 90-122) proposed a top-down inhibitory mechanism for deprioritizing old information, termed visual marking. We investigated the influence of visual marking on RTs and ERP components in a series of experiments involving a color-form conjunction search task. The first experiment examined whether the preview benefit modulates the PCN peak latency. In the two preview conditions, one of the two distractor sets sharing either color or form with the target was presented in advance. Processing of the search array was more efficient in the preview trials than in the standard conjunction condition as indexed by faster RTs and shorter PCN latencies. However, the slope ratios absent: present in the preview conditions indicate that old distractors interfere with search, especially when no target is present.

To directly measure the deployment of attention to distractor locations over time, we flashed a task-irrelevant probe stimulus while participants performed a preview search for a conjunction target (Kiss, Wolber, & Wascher, subm.). The modulation of early ERP components elicited by the probe suggests differential allocation of attention to old and new distractors before target detection. An early positive component of the probe ERP (P1) was reduced at electrode sites contralateral to the target when the probe occurred around an old distractor, suggesting attentional suppression of irrelevant old positions (see Figure 4). Probes also elicited enhanced negativity (N1) when presented at new distractor locations but only on the same side of the display as the target – which is consistent with an attentional gradient explanation. In the interval before onset of the new items we found no

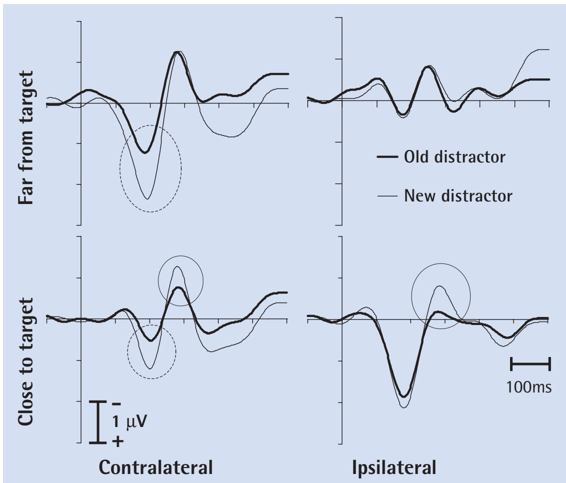

Figure 4: Allocation of attention to old and new distractor locations during search in the preview condition as indicated by the differences in the ERP elicited by the probe: P1 was reduced at contralateral electrode sites for probes at old distractor locations as compared to probes at new distractor locations (dotted circles), suggesting suppression of previewed locations. The enhanced N1-component in response to probe stimuli at new distractor locations close to the target (solid circles) most probably reflects an attentional gradient.

evidence for sensory suppression at old distractor locations. However, there was enhanced processing of old distractors as indicated by an increase in N1 amplitude when old distractor locations were task-relevant, that is, the target was expected to appear at a location previously occupied by an old distractor. Results are consistent with an inhibition account of the preview benefit, which can be flexibly applied to irrelevant old locations if required, but is not powerful enough to eliminate the influence of old information still present in the display.

In cooperation with Steve Tipper (University of Bangor, Wales, UK).

Closely related to the suppression of old distractors in a visual-marking paradigm is a phenomenon called inhibition of return (=IOR). It reflects the delay of responses to non-informatively cued spatial stimuli whenever the cue has been transiently presented at the location of the subsequent target. We investigated the ERP components related to IOR in two very similar tasks that could (transient cues) or could not (sustained cues) evoke IOR (Wascher & Tipper, subm.). It has been hypothesized that inhibition is present in both tasks, but that it might be masked by a counteracting excitation process under particular circumstances (e.g., sustained cues). Behavioral measures cannot reveal the interplay between inhibition and excitation, and hence converging techniques such as ERPs are necessary. First, P1 suppression was observed for all targets presented at a cued location. Second, a later negative component (Nd250) was *increased* with sustained cues, this possibly reflecting the excitation process. Third, a negative component at right parietal electrode sites (Nd310) was the most specific ERP-component for IOR. It appeared *only* in conditions in which behavioral IOR-effects were observed. Results of a second study confirmed the link between P1 and inhibition, because it varied with the spatial relationship between cue and target. This second study also demonstrated that the Nd310 effect is specific to inhibition associated with the object/location cued.

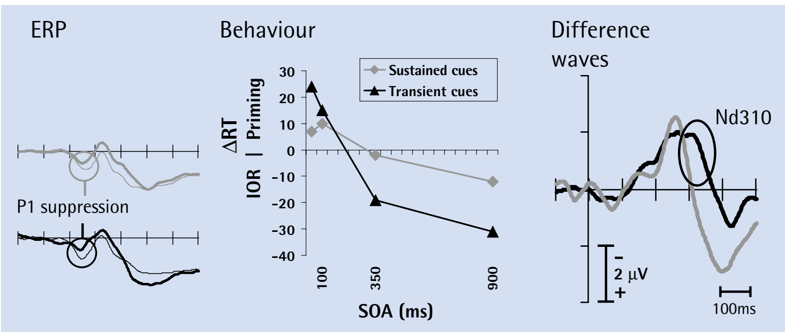

Figure 5: ERPs, behavioral data and difference waves as obtained in an IOR task with transient and sustained cues. The ERP shows that P1-suppression for the cued location is not related to overt behavior which shows reliable IOR with transient cues only. The ERP component most sensitive to IOR is the right parietal Nd310, reflecting the effort to reorient attention to a previously inhibited location.

Project Area:

Efficient and Inefficient Visuo-Motor Transformations

The second area of research addresses the question of the mechanisms underlying action-related visual spatial information processing. From several experiments investigating the Simon effect Wascher, Schatz, Kuder, and Verleger (2001) concluded that irrelevant spatial information may influence performance via two separable mechanisms. One is assumed to be based on efficient visuomotor transformation, facilitating a spatially corresponding response due to priming. The other mechanism is assumed to be based on a more time-consuming cognitive coding of spatial stimulus and response codes, resulting in an interference between the two. In a series of experiments the properties and boundary conditions of these two mechanisms were investigated.

Temporal Characteristics of Visual Spatial Processing

Visual information processing takes place within at least two main distinguishable pathways – the dorsal and the ventral stream. Recent findings have led to their functional distinction – a "sensorimotor" pathway for dorsal and a "cognitive" pathway for ventral processing. In addition, there is also evidence for a temporal dissociation: The dorsal stream is likely to be immediately recruited, but gives rise to short-lived representations only, which may then be processed by the ventral stream onto premotor areas for delayed movements. Based on these findings we performed experiments to measure the proposed temporal dissociation between the two systems.

In cooperation with Anthony Greenwald (University of Washington at Seattle, USA) and Jochen Müsseler.

In a masking paradigm participants performed a choice-reaction task to the localization of a hardly visible stimulus. In a first condition they were forced to respond 400 ms after stimulus presentation, in a second condition after a delay of 2500 ms. Results revealed better performance for immediate responses as compared to delayed responses, which supports the theory that masking of visual stimuli affects only their conscious identification (ventral) but spares their sensorimotor processing (dorsal).

A similar temporal distinction was observed in a series of experiments in which Simon effects for vertical and horizontal S-R relations were compared. The time course of the effect (obtained by analyzing RT distribution; see Figure 6) as well as LRP differences between corresponding and noncorresponding trials indicated a fast and transient influence of the horizontal spatial code, whereas the vertical code exhibited a later but more stable Simon effect. This was further supported in experiments in which experimental manipulations led to shorter or prolonged RTs. Thus, it was concluded that transient effects of S-R correspondence (horizontal) is based on sensorimotor transformation whereas the vertical Simon effect relies primarily on cognitive stimulus and response codes (see Figure 7; Wiegand & Wascher, subm.).

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However, this distinction seems to be neither related to the spatial dimension per se nor to an overlap between anatomical factors and response-location codes. In a series of experiments transient Simon effects were also observed for vertical S-R relations when the Simon task was modified such that the S-R mapping varied from trial to trial.

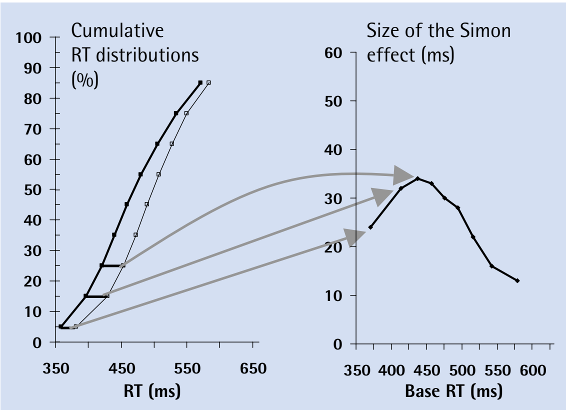


Figure 6: Calculation of effect functions. From the cumulative RT distributions the time course of a behavioral effect can be defined as the sequence of the size of the effect for successive RT deciles.

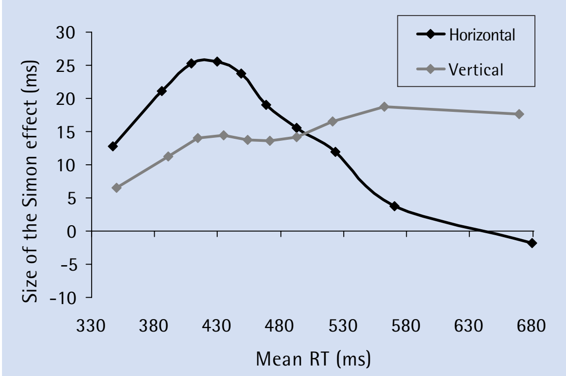


Figure 7: Time course of the Simon effect for horizontal (gray) and vertical (black) S-R relations.

The role of visual localization for S-R correspondence can also be tested by using moving stimuli. In contrast to spatial localization, direction encoding does not show any hemispheric organization. Neurons in area MT in which direction is encoded have large receptive fields that cover both visual hemifields. Moreover, different directions are coded in columns of area MT in both hemispheres in the same way. Thus, localization and direction-encoding processes might show distinguishable influences on behavior. Different types of moving stimuli were used and the properties of the influence of stimulus localization and movement direction were evaluated. As for horizontal and for vertical stimulus arrangements, decaying and sustained S-R correspondence effects could be dissociated. Only if the stimulus arrangement did not allow spatial localization (with moving letter strings that showed no spatial displacement) sustained effects were obtained.

One central question about the transient nature of some Simon effects is the temporal anchoring of the decay function. Most studies assumed the localization process to be temporarily invariant. Thus, when manipulating, for instance, stimulus discriminability the onset of the decaying function was assumed to be stable whereas post-localization processes should change. However, Proctor and Lu (1994, *Psych Res, 56,* 185-95) demonstrated that also stimulus properties that affect the speed of localization might influence effect size. By using the capability of the PCN to identify the moment of stimulus detection, it can be shown that the decay function can be anchored at the localization process in those conditions in which localization clearly precedes target identification (Wascher, subm.).

On the Interface Between Perception and Action

The interference between stimulus and response codes, which underlies S-R correspondence phenomena, is assumed to take place within a response-selection stage. One stream of evidence in support of this notion derives from precuing experiments. To gather more information about the origin of SRC effects, the influence of preliminary information about the required response on the Simon effect was tested (Proctor, Lu, Van Zandt, 1992, *Acta Psych, 81*, 53-74). Results revealed an enhanced Simon effect for valid, and a reduced Simon effect with invalid cueing as compared to a regular Simon task. This increased Simon effect for the valid-cue condition was interpreted as support for the response-selection theory.

However, by means of EEG we were able to demonstrate that the enhanced Simon effect in the valid condition is due to perceptual factors. In particular, PCN latency clearly showed that this phenomenon is most probably produced by a perceptual acceleration with response-stimulus correspondence (Wascher & Wolber in press).

In further experiments we used response precues in order to avoid visuospatial interference. Either a central symbolic or a tactile cue was presented instead of the arrows used in the previous experiments. As a result, the enhanced effect in the valid-precue condition disappeared. The differences between the two validity conditions were reduced in the symbolic-cue condition and absent in the tactile-cue condition. The differences concerning PCN peak latencies disappeared as well. In conclusion it was shown that the increase of the Simon effect with intentional cueing owes to perceptual factors and cannot be taken as support for the response-selection account (Buhlmann & Wascher, subm.).

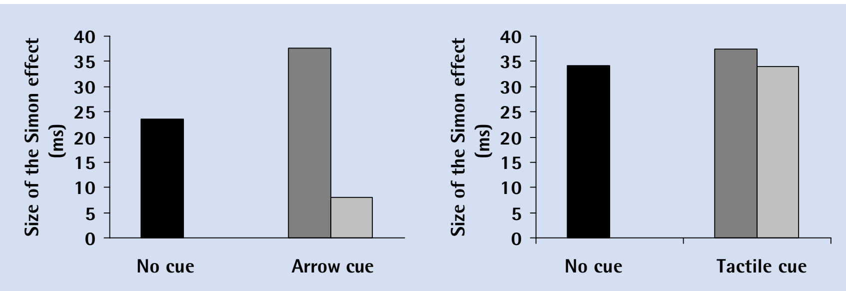


Figure 8: The size of the Simon effects (y-axis) with valid and invalid directional precuing for symbolic color cues (left panel) and tactile cues (right panel) each compared to a regular Simon effect.

Buhlmann, I., & Wascher, E. (subm.). *Intentional cueing does not affect the Simon effect.*

Kiss, M., Wolber, M., & Wascher, E. (subm.). *Probing the time course of the visual marking effect.*

Wascher, E. (subm.). *Perceptual speed and the Simon effect.*

Wascher, E., Schatz, U., Kuder, T., & Verleger, R. (2001). Validity and boundary conditions of automatic response activation in the Simon task. *Journal of Experimental Psychology: Human Perception & Performance, 27(3),* 731-751.

Wascher, E., & Tipper, S. (subm.). *Revealing effects of non-informative spatial cues: An EEG-study of inhibition of return.*

Wascher, E., & Wolber, M. (in press). Attentional and intentional cueing in a Simon task: An EEG-based approach. *Psychological Research.*

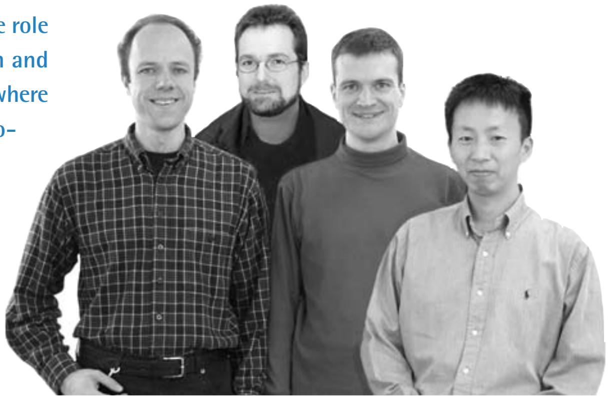
Wiegand, K., & Wascher, E. (subm.). *Dynamic aspects of S-R correspondence: Evidence towards two Simon effects?*

Wolber, M., & Wascher, E. (2003). Visual search strategies are indexed by event-related lateralizations of the EEG. *Biological Psychology, 63(1),* 79-100.

Wolber, M., & Wascher, E. (subm.). *Cortical correlates of visuo-spatial processing.*

3. Cognitive Robotics

The research unit "Cognitive Robotics" investigates the role of internal, sensorimotor models in visual perception and action selection. A synthetic methodology is pursued, where hypothetical mechanisms are formalized, implemented in robotic agents, and tested in the real world. Artificial neural networks are used to endow the robots with the ability to learn sensorimotor relations in the interaction with their environment.



Ralf Möller
Wolfram Schenck, Heiko Hoffmann, DaeEun Kim

Background

Ralf Möller (head)
Heiko Hoffmann
DaeEun Kim
Bruno Lara
Wolfram Schenck

"Representationalism" assumes a stable relationship between entities in the external world and their internal, neural representations. According to these widely accepted concepts, the task of vision is to produce a representation from images of the external world that contains the relevant information, thus vision is assumed to be a mere transformation of sensory information into a sensory representation. All cognitive processes, including action selection, operate on this representation. As a consequence, perceptual processes and action selection are treated as completely separated systems.

This view is not only undermined by accumulating experimental evidence for the sensorimotor character of perception, but can also be challenged from the conceptual perspective. We have to ask whether a transformation of sensory information actually simplifies its interpretation. The representation can be extremely complex, because the perceptual part alone cannot decide about the relevance of different aspects and may therefore be difficult to analyze by other cognitive processes. When discussing the form of sensory representations, we are caught between the extrema of compact (grandmother-neuron-like) representations on the one side, which suffer from problems like combinatorial explosion, and distributed representations on the other side, for which it is unclear how they can be interpreted by the subsequent processing stages. Representationalism is always susceptible to the "homunculus problem" in some form: Representationalism may just impose the task of interpretation upon the behavioral subsystem instead of solving it. In general, a transformation cannot add any "meaning" to sensory information. Finally, the fact that satisfactory notions explaining invariance and constancy in visual perception are still lacking may be the result of general conceptual problems of representationalism.

We attempt to overcome the problems of the representationalist framework not by abandoning representations, but by replacing purely sensory with sensorimotor representations. According to this view, the brain associates self-generated actions with the changes of the visual information these actions cause. A sensorimotor representation will thus integrate an "efference copy" and the "reafference" of the corresponding actions. It is part of internal models of sensory action effects, either "forward models" that are able to predict the course of sensory events resulting from the agent's actions, or "inverse models" that produce the motor commands required to achieve some goal. Based on such internal models, the agent could interpret a visual scene by anticipating the consequences of its actions, thus directly assigning a behavioral "meaning" to the visual information. While representationalism explains the recognition of an object in purely sensory terms – a chair is recognized because it exhibits certain visual features like parallel lines for its feet –, our anticipation approach indirectly exploits visual information to predict behavioral consequences – a chair would be recognized by predicting the sensory feeling of support in the action of sitting down. This may give a completely different perspective on invariance and constancy. The anticipation approach can be viewed as an interpretation of Gibson's notion of "affordances", according to which an object directly offers its behavioral meaning to the observer.

Methods

Our research strives to demonstrate that the anticipation concept is actually able to produce adapted behavior in artificial agents, which would reflect their perceptual capabilities. From our point of view, basic perceptual capabilities are an understanding of the spatial organization of the world and of shape and physical properties of objects. One setup, a robot arm with stereo vision system, shall be endowed with the capability to grasp objects, thus showing an "understanding" of their shapes and spatial arrangement; the other setup, a mobile robot, shall exhibit intelligent locomotion behavior including obstacle avoidance, gap estimation, and dead-end recognition. Neural networks are used to learn sensorimotor relationships in the interaction of the agents with the environment and will subsequently be used to guide the agents' actions. We focus on recurrent neural networks (associative memories) as internal models, since they can be used as general models that allow both anticipation (as a forward model) and the selection of behavior (as an inverse model).

Project Area:
Learning Methods for Internal Models

Internal models can be learned by collecting examples during the interaction of an artificial agent with its environment. From these examples, the underlying relationships between sensory and motor signals have to be extracted and represented in a more compact way, an ability which is offered by artificial neural networks. Learning sensorimotor models, however, poses special requirements which not all neural network methods fulfill. Inverse models – which deliver the appropriate motor command given a sensory goal state – are usually "one-to-many mappings": The same goal state can be achieved in different ways. An example is the kinematic model of our robot arm: One and the same gripper-tip position can be reached in infinitely many joint angle configurations. The attempt to learn such a model in a classical multi-layer perceptron is doomed to fail: Perceptrons are function approximators and will simply average over the multiple possible outputs (e.g., joint angles) presented for each input (e.g., desired gripper-tip position); the model will therefore deliver an invalid joint angle set.

This was the motivation to develop neural networks that can approximate not only functions, but arbitrary manifolds of data. "Local principal component analysis" (local PCA) is one suitable method; there, a set of data points is approximated by a much smaller set of hyper-ellipses. After the training, the data points are discarded and each of the ellipses represents the data points in a local region. This is shown in Figure 1: In this synthetic example, ten ellipses represent the training data (gray points). The data points represented by the ellipse in the lower left corner are printed in black. The task of the local PCA network is to find the right positions and shapes of the hyper-ellipses. We developed a novel method that extends a robust vector quantization method ("Neural Gas") to local PCA (Möller & Hoffmann, in press). In contrast to most previously suggested methods, our extension is an online method which immediately updates the representation when a new observation is available. To make such a method applicable, robust and fast neural principal component analyzers had to be developed (Möller, 2002; Möller & Könies, in press). A side-result was the development of a novel learning rule for minor component analysis (Möller, subm.).

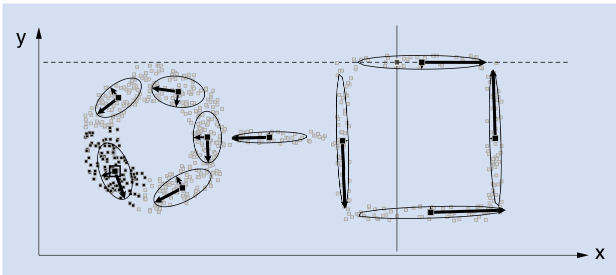


Figure 1: Learning of internal models: A set of examples (gray points) is approximated with a set of ellipses, and a constraint recall associates input and output values.

The novel learning system was tested in a standard pattern-recognition task (handwritten digits) where it performed as well as previously suggested approaches of the same class (Möller & Hoffmann, in press). In pattern-recognition tasks it is only determined to which hyper-ellipse (each of them associated with a class label) a novel pattern belongs. For an application as an internal model, however, a relation between an input signal and an output signal has to be established. The set of hyper-ellipses can be seen as an abstract instance of a "recurrent" neural network, a network capable of pattern completion. We developed a method where arbitrary dimensions of data space can be selected as either input or output. When specific values are given for the input components, the network completes the pattern with appropriate values for the output components. Figure 1 shows a recall where the input (x direction, e.g., the gripper position) is specified and the network delivers a corresponding output (y, e.g., a joint angle set to bring the gripper into this position). The solid line visualizes the input "constraint", and the network finds the closest intersection of the hyper-ellipses with this constraint, leading to an output value (dashed line). In the example depicted, two solutions are possible – in contrast to feed-forward neural networks like perceptrons, the network finds one of them, thus the recall is possible even for one-to-many relationships. Moreover, without another training process, the network could be used to find the inverse relation – in the example, the y-value would be input and the x-value output. One and the same network can thus be used as inverse model, or as forward model.

The recall method was applied for the learning of a kinematic arm model for our robot arm (Hoffmann & Möller, in press). Based on a simulation of the arm, ten-dimensional training data consisting of six joint angles, three gripper-tip coordinates, and one collision signal were collected by generating random joint angles and registering the other variables. A local PCA network was trained and subsequently applied both as an inverse model (finding the joint angles for a desired gripper position) and as a forward model (predicting the gripper position achieved with a given joint angle set), demonstrating the feasibility of this approach.

Project Area: Foveation Control

Interpreting a visual scene usually involves the fovealization of objects by eye movements or the scanning of different parts of an object by multiple saccades. Saccades are also preceding and guiding arm movements, and it is known that, at least in the early processing stages, limb movements are encoded in eye-centered coordinates. Internal sensorimotor models related to the effects of eye movements are therefore tightly integrated in perceptual processes if the general framework outlined above is accepted. For the pan-tilt unit of our robot arm setup we developed a foveation controller that learns to produce the appropriate eye movement (pan, tilt, and vergence) to bring the image of an object into both foveae. The core of the foveation controller is an inverse model that receives kinesthetic information – the current pan, tilt, and vergence position – and the coordinates of the selected target in the left and the right input image, and then produces an appropriate saccade as output.

When attempting to train the foveation controller, one encounters another problem that burdens the learning of internal models, the "missing teacher signal". The foveation controller is implemented as a neural feed-forward network, since the optimal saccade for a given target location is unique (the relation is no one-to-many mapping). To compute the error signal required in the training, we have to provide the network with the correct saccade for each example of the input signals the information on the correct saccade, however, is not available without an external teacher. Several methods (e.g., feedback error learning, distal supervised learning) have been put forward to overcome this problem. We suggest another solution, a "directed search" in the sensorimotor space based on an evaluation signal that exploits the averaging property of feedforward neural networks (Schenck, Hoffmann, & Möller, 2003). The learning process starts with random movements of the pan-tilt unit and includes every movement in the set of training examples as long as it improves the fovealization of the target, even if it is not perfect. While the training set thus obtained will mostly include imperfect examples, a feedforward network trained with these data will produce already fairly good saccades, since it will learn an average between examples in which the saccade overshoots and examples in which the saccade undershoots the target. In a staged learning regime, the trained controller of the first learning stage can be used to produce better training examples in the second stage.

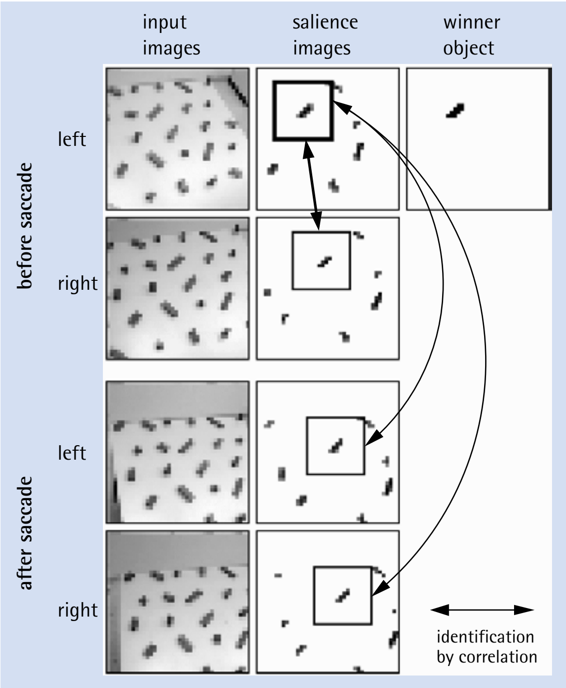


Figure 2: Foveation controller: Target selection (before saccade) and target re-identification (after saccade).

Figure 2 visualizes the visual processing required to derive target position and evaluation signal. According to some goal category (here: color), salience images are produced from the image of the left and right camera. Prior to the saccade a target is selected (currently with respect to its size and distance from the image center) in one image. The region surrounding the target is then used in a matching process to find the same target in the second image. The two target positions are part of the input training signal. A similar process takes places to re-identify the target after the saccade has been executed. Together with the pre-saccadic target position, this information allows to evaluate the quality of a saccade. In the recent version of the foveation controller, obtained after a three-stage learning process, small colored wooden blocks lying on a table can be foveated with 1-2 saccades (object center of mass within a center region of 0.25% of the total image size).

Project Area:

Visually Guided Reaching and Grasping

In the kinematic arm model described above, target position was defined in Cartesian coordinates in space. In a reaching/grasping task, however, input to the inverse model is a pair of images of an object. From the information about position and shape implicitly included in this image, a set of joint angles has to be derived. Again we applied the local PCA approach (with another method of this class) to obtain the internal model (Schenck et al., 2003). The data were obtained in an automatized procedure: The arm placed a wooden block on the table (by randomly selecting the joint angles based on an inverse kinematic model), registered the joint angles, and moved out of sight; an image of the object on the table was taken and stored; the block was again picked up by the arm, a new random position was chosen, and so forth.

We found that the success of the learning process crucially depends on both the preprocessing and encoding of the input data. It proved difficult to train the network when the pixels of the two images were directly used as input data a likely reason being that the training data do not form a contiguous manifold in the data space. We therefore applied a simple pre-processing scheme: Position information was extracted from an extremely lowpass-filtered version of the input image, and orientation information was obtained from a histogram of the edge orientations in the image. Moreover, the network performed better when the joint angles were encoded topologically by a set of four neurons (with Gaussian receptive fields in the angle space) instead of directly using the joint angles.

The trained network produced reaching/grasping movements with a mean position error of approx. 4 cm on the table surface, and an orientation error of approx. 3 deg. With this precision, grasping succeeded in more than 90% of the trials.

As a first step towards an integrated sensorimotor model, we combined the foveation controller and the inverse reaching/grasping model (Schenck et al., 2003). In the combined model, the information on the image position was replaced by kinesthetic input from the pan-tilt unit, after the object had been centered in the two images by the foveation controller. The overall grasping performance was worse in the combined model, but supposedly for technical rather than conceptual reasons; we are currently striving to overcome this problem, for example by a modification of the arm segments to enlarge grasp space. Figure 3 shows a successful example of visually guided reaching and grasping in the combined model.

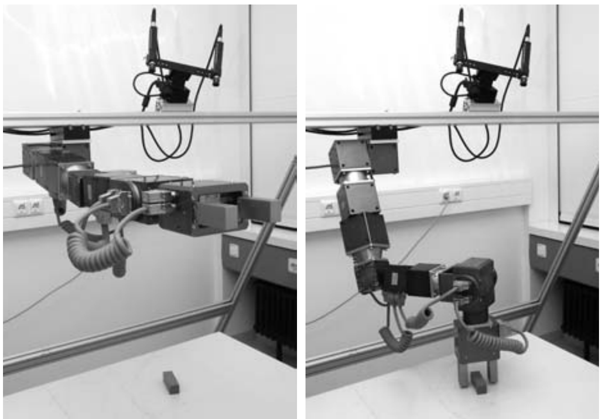


Figure 3: Visually guided reaching and grasping: The pan-tilt unit foveates the target (left), and the arm grasps the object in the correct gripper orientation (right).

Project Area:

Visually Guided Mobile Robot Locomotion

The second robot setup, a mobile robot with vision system, served as another test bed for our sensorimotor theory of visual perception. Based on internal sensorimotor models, the robot should exhibit adapted behavior as an indicator of its perceptual abilities. Navigating through a tight passage way would, for example, show that the robot can relate visual features to its own body size. We are currently collecting data in the experimental setup shown in Figure 4: The robot moves within an array of obstacles and registers the movement parameters together with the images seen by the onboard camera and the tactile signals from the bumpers.

Part of this database was used to train a local PCA network (see above), however, the performance of the network as a predictor of future visual and tactile signals proved insufficient over long prediction times. A feedforward neural network (a multi-layer perceptron trained with resilient backpropagation) achieved better results even for a smaller number of network parameters; the reasons for this difference are currently analyzed and may entail modifications of the training method.

In the training of internal models for this robot setup we encountered a problem of imbalanced data sets: Most of the time, local visual predictors saw no changes, since no object was passing through their receptive field. As the majority of training data were of this kind, the interesting examples were widely ignored by the network in the training process. Local PCA networks as described above offer a potential solution for this problem. Training data can be split into one set with and another set without visual changes and learned by two separate networks. After the training the two sets of ellipses are merged in a single network and used for recall. This would not be possible with a feedforward neural network.

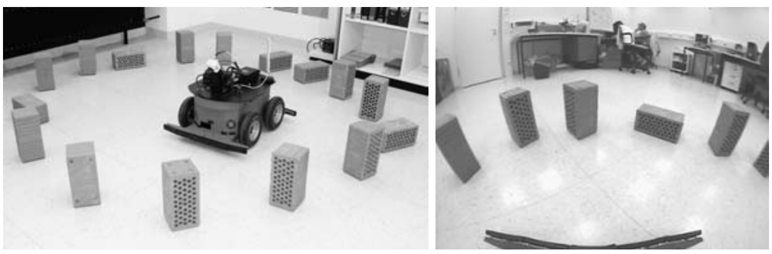


Figure 4: Visually guided mobile robot locomotion: Setup for the collection of training examples (left) and image as seen by the robot's camera, taken from the database (right).

Project Area: Artificial Mouse

The goal of this EU-funded project is to develop a model of the somatosensory processing in the rodent whisker system and to exploit the insights for the construction of a sensitive technical tactile system. At the present state, work focuses on the development of the peripheral parts, the artificial whiskers. Figure 5 shows three of the prototypes based on magnetic sensors; artificial whiskers based on other technologies (piezo, optical) are under construction. An entire, movable array of whiskers will be completed in the near future and mounted on a mobile robot. Based on this technology we will explore visuo-tactile and sensorimotor integration and study the role of synchronization between neurons in these processes; a first mathematical analysis of synchronization conditions has been performed in preparation of subsequent work (Kim, 2003).

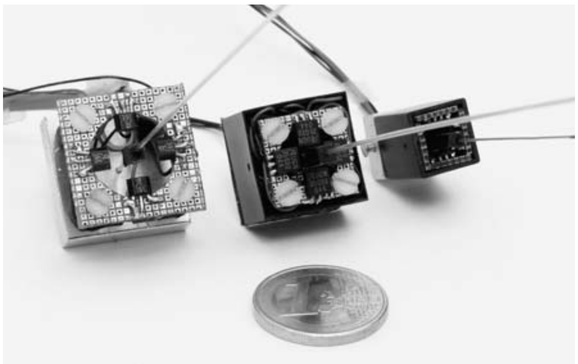


Figure 5: Tactile perception: Three prototypes of an artificial whisker system, all with magnetic sensors surrounding the whisker shaft.

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4. Sensorimotor Coordination

This research unit investigates governing principles in the formation and coordination of neural central commands in human movements. We are developing a combination of precise measurements of kinematic, dynamical, and neurophysiological variables with sophisticated modeling of the human biomechanical periphery. One goal of our research is to understand the emergence of controllable degrees of freedom from the interplay of perception and action neural systems.

Ken Ohta, Rafael Laboissière
Anne Häberle, Michiko Inoue

Rafael Laboissière (head)
Anne Häberle
Michiko Inoue
Ken Ohta

Background

Many of the key issues in human motor control were formulated by the Russian neurophysiologist and movement pioneer Nikolai Bernstein in the first half of the 20th century, some of them including the degrees-of-freedom problem, motor equivalence, and non-univocality of motor commands and peripheral effects. Most of these issues are currently under investigation, but questions about the coordination of neural central commands in human movements are still open. One reason is the overwhelming complexity of the human nervous system and its biomechanical periphery. Indeed, a complete research agenda in this area should involve several levels of experimentation, including behavioral studies, neurophysiological, and biomechanical modeling. The research program carried on in the Sensorimotor Coordination unit is intended to accomplish this.

One of the themes under study is how physical and neurophysiological aspects of the biomechanical periphery affect the formation of commands issued by the Central Nervous System (CNS). On theoretical grounds, our work is based on the Equilibrium Point (EP) hypothesis of motor control in its lambda-model version (Feldman, 1986, *J Motor Behav, 18,* 17-54). According to that theory, movements result from changes in neurophysiological control variables which shift the equilibrium state of the motor system. These would remove from the CNS much of the computational burden of controlling the body segments. One implication of this theory is that the brain does not need to "know" all the details of the biomechanical periphery and, thanks to the hierarchical organization of the motor systems, signals delivered by the CNS usually have a simple formulation.

This idea of simplicity has been challenged by experiments done by Gomi and Kawato (1996, *Science, 272,* 117-20). Using a sophisticated servo-controlled planar robot, they measured the mechanical characteristics at the level of the hand during rapid two-joint arm movements. By way of a simplified biomechanical model of the periphery, the authors were able to deduce the virtual equilibrium trajectory at the hand level. The trajectories obtained had a quite complicated shape, this contradicting the EP hypothesis. In response to that study, we have shown that unless one has a realistic model of the neurophysiological periphery, it is not possible to make correct inferences about the central commands (Gribble, Ostry, Sanguineti, & Laboissière, 1998, *J Neurophysiology, 79,* 1409-24).

Progressing on this paradigm, our unit investigates the formation of central commands in other systems, like the human jaw. The experimental setup is shown in Figure 1. The participant's lower teeth are attached to the tip of a force-feedback robot that can apply perturbations during the course of the movement, similar to the experiments that have so far been realized with the arm. Some results are shown in Figure 2. The left panel depicts two jaw opening movements with protrusion and retraction perturbations. The data on jaw reaction force (arrows point from the curves) support the theory of continuous shift of the equilibrium trajectory, at least for this kind of movement. Another application of this setup is the

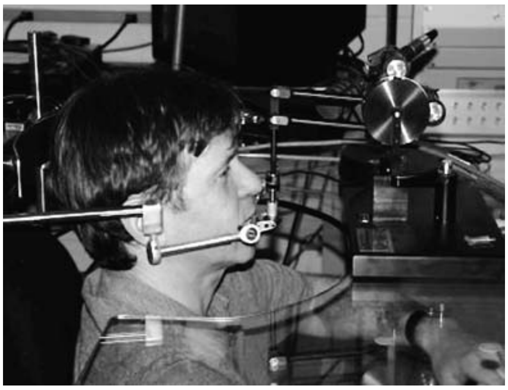

Figure 1: Experimental setup for measuring the mechanical characteristics of the mandibular system. The participant sits in front of a force-feedback controlled Phantom robot. The tip of the last segment of the robot arm is attached to his/her lower teeth through a dental appliance. Perturbations are applied to the jaw during speech and non-speech tasks and the stiffness and viscosity of the jaw can be determined from the measurements of the force transducers.

determination of the jaw mechanical properties, like the stiffness ellipses (right panel of Figure 2). These results will allow us to investigate the dynamical degrees of freedom of the jaw and to explain the differences in frequency of oscillation of the jaw in different tasks, like speech and mastication.

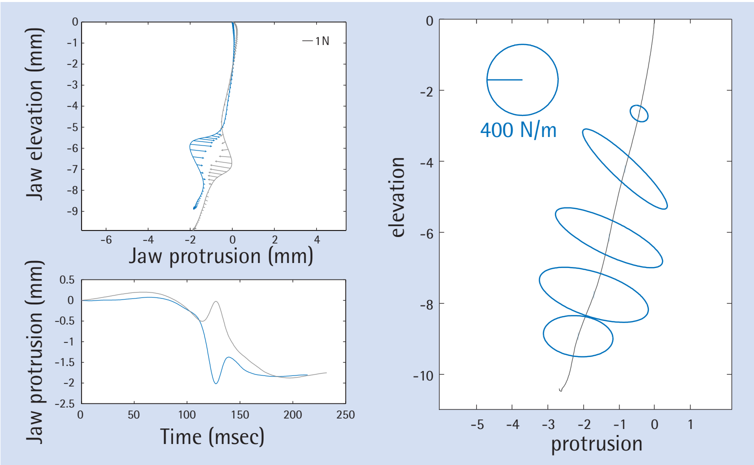

Figure 2: Measurements obtained with the setup in Figure 1. Left-top panel: Position of the lower incisors during the production of the /ia/ vowel. Subject is looking to the left. Protruding and retracting perturbations have been applied and the arrows show the measured reaction force. Left-bottom panel: Time course of jaw protrusion for the same perturbed trials as above. Right panel: Inferred stiffness ellipses for several repetitions of the /ia/ syllable. Ellipses have been superimposed on the mean trajectory.

Research in our unit will be extended with a combination of new experiments and modeling efforts. Focusing on orofacial motions, we are designing experiments to test some of the core ideas at the institute, especially the relationships between perception and action. The planned studies include the investigation of self-other effects in the perception of labial movements, and the effects of preparation of speech movements on the perception of similar resulting sounds. Moreover, we are investigating the formation of central commands in constrained movement tasks, like the rotation of a crank. In all these research fronts, the Sensorimotor Coordination unit pays attention to a careful implementation of models in motor control which, in combination with sophisticated experimental setups, will hopefully extend our level of understanding of human movements.

Methods

Laboratory Equipment

Our laboratory is equipped with different experimental systems, allowing for a wide range of studies in human movement control. The Optotrak 3020 system is a highly accurate 3D motion and position measurement system based on infra-red (IR) sensing. The Optotrak is currently used to record the movement of the body's rigid parts in 6D (three positional and three rotational degrees of freedom – DOF), like jaw and head. For soft-tissue structures like the lips, where the number of DOF is not clearly defined, we do recordings with a relatively high number of IR markers. This allows for a good kinematic description of orofacial movements.

For the haptic interface, the laboratory is equipped with two Phantom robots, which have three DOF that can exert feedback-controlled force fields in real time, allowing the simulation of diverse virtual conditions that we require. The two current applications of the robots in the laboratory are: (1) the measurement of mechanical impedances of the jaw and the finger/wrist systems, and (2) the simulation of virtual situations for measuring the participants' interaction forces while controlling visually guided movements. Two Nano-19 force/torque transducers (ATI Inc.) are attached to the tip of each robot. They measure the reaction forces exerted by the participants in perturbation or virtual reality experiments done with the Phantoms.

Electromyographic (EMG) measurements are done with the Amplifier System by Grass Telefactor Inc. We have two quad amplifiers allowing simultaneous measurement of the activity of up to eight muscles. A variety of electrodes is used, most of them surface electrodes whose electrical characteristics are adapted to the different muscles involved in the experiments. We are collecting data for the orofacial systems (jaw, tongue, and larynx) using both surface and needle EMG. The system will be extended with two extra quad amplifiers, so as to enable recordings of the muscles involved in the control of wrist/finger movements.

Physiological and Biomechanical Modeling

Sophisticated models of the biomechanical periphery are being developed. The models which are implemented as a computer simulation include central neural control signals, position- and velocity-dependent reflexes, reflex delays, muscle properties such as the dependence of force on muscle length and velocity. The muscles are represented as attachments to the body's several rigid structures (jaw, skull, and hyoid for the head; metacarpals and phalanges for the hand), and separate bone dynamics are computed. As the controlling principle, we adopted the Equilibrium Point (EP) hypothesis. Results of the simulations will be compared with the empirical results obtained with Optotrak, the Phantoms, Force/torque transducers, and the EMG systems.

Project Area:

Empirical and Modeling Studies of Physiological Systems

Mechanical Impedance of the Jaw

This project is done in collaboration with Prof. David Ostry, Dept. of Psychology, McGill University, Montreal, and is funded in part by the National Institutes of Health grant 5R01DC004669-02.

This project aims at studying the control of human orofacial movement that focus on the jaw. The goal is to understand the ways in which neural signals interact with orofacial mechanics to determine movement outcomes in speech. The experimental approach is novel in the context of orofacial research: the use of a servo-controlled robotic manipulator to deliver precise mechanical perturbations in 3D to the jaw. The studies are the first to systematically document the jaw's mechanical behavior. They also examine participants' ability to adapt to movement-dependent mechanical loads (Laboissière, Shiller, & Ostry 2001). By determining the extent to which participants adapt to various loading conditions and the generalization that occurs to novel loads and tasks, we document the properties of the mechanical periphery that the nervous system specifically compensates for in the production of orofacial movement. The work provides an important bridge between research on orofacial movement and the literature on limb motor control.

EMG and Kinematic Studies in Speech Production

This project is done in collaboration with Dr. Philip Hoole, Phonetics Dept., Ludwig-Maximilians-Universität München, and Dr. Kiyoshi Honda, from the Advanced Telecommunications Research Institute, Japan.

In this project we address questions about the muscle command organization in speech tasks. With surface and needle EMG measurements, we collect data on muscle activity of different structures involved in speech production, namely larynx, tongue, and jaw. More specifically, we are interested in studying the precise relationships between muscle commands and the resulting kinematics of the systems. In the case of the jaw, pilot experiments have been carried out in which the positional and rotational coordinates of the jaw with respect to the head were recorded simultaneously with the EMG activity of seven muscles involved in the jaw positioning control. Comparison of the empirical results with models of formation of central commands to control specific degrees of freedom of the jaw (like protrusion and opening) will follow.

Project Area:

Optimal Trajectories in Constrained Movements

This project was partly done in collaboration with the Riken Institute, Japan, and the Faculty of Engineering, Nagoya University, Japan.

Opening a door, turning a steering wheel, rotating a coffee mill are typical examples of human movements constrained by the external environment. The constraints decrease arm mobility and lead to redundancy in the distribution of interaction forces between the arm joints. Due to this redundancy, there is an infinite number of ways to form the arm trajectory. Our question is how the CNS resolves this excess of degrees of freedom. To investigate this problem, trajectories of the human arm in a crank-rotation task were observed (see Figure 4). Formation of point-to-point constrained rotation movements are explained using a criterion minimizing hand contact force change and actuating force change over time. The experiments reveal a close matching between the prediction and the participants' data (Ohta, Svinin, Luo, Hosoe, & Laboissière, subm.), indicating that smoothness principles are important in forming constrained movements.

Figure 3: Experimental setup for measuring the lip movements with the Optotrak. The participant is placed in front of the cameras (left-top corner of the picture) with the infra-red Optotrak markers placed on him. Head movement is captured by measuring the position of the three markers on the head-mounted triangle, allowing the computation of the three positional and three rotational coordinates of the skull. Eight markers are used for the lips, which gives a quite accurate representation of both shape and dynamics of labial movements.

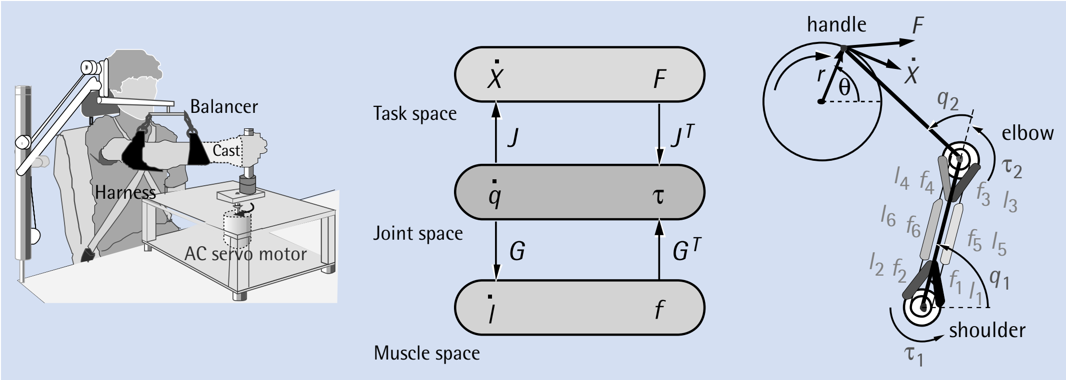

Figure 4: Left panel: Experimental setup of the crank-rotation task. An AC servo-motor produces the viscous field. The force the participant exerts on the handle is measured with a force transducer. Center panel: Transformations between the different spaces of description of the movement task. Right panel: Schematics of the model showing the two-joint planar arm, the six muscles around the shoulder, and the elbow as well as handle path and direction of exerted force.

Project Area: Self/Other Effects in Lip-Reading

Interactions between perception and action at different levels of the cognitive system have been shown in many empirical studies. However, questions still remain about the way humans can take advantage of their own motor schemas in order to recognize movements related to them. Knoblich and colleagues have addressed the issue of whether individuals can distinguish movements or predict outcomes of movements when seeing self- or other-generated actions (see Section 1.5). Some of the tasks involved in these studies were drawing characters and throwing darts. The main result was that participants are better at recognition and prediction tasks when they observe their own actions. We will extend these studies to a similar self- and other-recognition task of lip movements, but with better-controlled experiments (see Figure 3). Lip movements for selected speech tokens (mostly labial segments) are recorded with the Optotrak system. A detailed kinematic analysis will be done after the collection of movement data. The goal of this analysis is to find pairs of subjects that have bigger inter- than intra-subject variability. The data recorded will be used as stimuli in the recognition task, with the same participants as for the production experiment.

Project Area: Mechanical Measurements in Ideomotor Effects

An extension of the ideomotor action experiments done in the Cognition & Action unit (Knuf, Aschersleben, & Prinz, 2001) is being realized in our laboratory. A similar experimental paradigm is being used, namely a billiard-like task where the participant controls the horizontal position of a ball on a screen, while it is moving upwards aiming to hit another ball at the top of the screen. In order to elicit both induced and task-oriented ideomotor effects, the participant can only control the ball during the initial phase of the movement (i.e., the instrumental phase). This is done by using a Phantom robot, which constrains the movement of the finger tip to a left-right horizontal straight line. During the second phase of the movement, the finger-tip position is frozen by the robot and the force the participant exerts measured by the force transducer. Preliminary results with 17 participants show a strong correlation between the force measured and the position of the moving ball with respect to the ball to be hit. The use of the Phantom robots and the force transducers allow precise time description of the ideomotor effect. This experiment will be extended to study the ideomotor effect in situations of social interactions, where two participants play simultaneously.

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Ohta, K., Svinin, M., Luo, Z., Hosoe, S., & Laboissière, R. (subm.). *Optimal trajectory of the constrained human arm reaching movements.*

Ostry, D. J., Shiller, D. M., & Laboissière, R. (2001). Jaw impedance and its influence on speech production. In K. Ito (Ed.), *Proceedings of the First International Symposium on Measurement, Analysis and Modeling of Human Functions, Sapporo, Japan* (pp. 353-358). Yokohama, Japan: Tokyo Institute of Technology.

Shiller, D. M., Laboissière, R., & Ostry, D. J. (2002). Relationship between jaw stiffness and kinematic variability in speech. *Journal of Neurophysiology, 88(5)*, 2329-2340.

Shiller, D. M., Ostry, D. J., Gribble, P. L., & Laboissière, R. (2001). Compensation for the effects of head acceleration on jaw movement in speech. *The Journal of Neuroscience, 21(16)*, 6447-6456.

5. Moral Development

The studies to be reported upon below connect with past research interests that focused on changes in moral understanding from an ontogenetic and a sociohistorical perspective (pursued in the context of LOGIC, a longitudinal study of children from 4 years on, and COHORT, an intergenerational comparison including GOLD participants). They deal with the role of morality in constituting identity and backing civic virtues. Besides, an interview schedule has been developed for the follow-up study of LOGIC. Its core question concerns the stability of moral motivation from late adolescence into early adulthood with a special emphasis on the influence of individual differences in the interpretation of and identification with gender roles.

Gertrud Nunner-Winkler
Doris Wohlrab, Marion Nikele

Project:

Moral Commitment and Identity

Gertrud Nunner-Winkler (head)
Marion Nikele
Doris Wohlrab

Theoretical Background

Erikson's classical account in the 1950s defined two types of criteria for identity: lifelong substantive commitments (to a partner, a calling, a world view) and the formal competence of upholding an inner feeling of consistency, continuity, and uniqueness (Erikson, 1959, *Identity and the life cycle*). Since then, identity problems have greatly magnified: Social differentiation and cultural pluralization produce consistency problems (e.g., conflicting role demands, clashes between subcultural value orientations). Revocable commitments (e.g., due to divorces, loss of employment or occupational changes, religious or ideological conversions) and rapid social changes impede the experience of continuity across the lifespan. Urbanization, bureaucratization, increasing anonymity may jeopardize the sense of uniqueness. From a third-person perspective no problems arise: Social arrangements allow to identify persons as incumbents of roles (e.g. by uniforms), as specific individuals (e.g., by thumb-print or passports) and as the same individuals over time (e.g., by the curriculum vitae or the genetic print). Identity is a first-person problem. Recent theories differ widely with respect to the theoretical solutions proposed. Substantive commitments have been rejected for rigidifying identity, been interpreted more flexibly – thus, Giddens (1991, *Modernity and self-identity*) claims that ever-changing lifestyle choices decide who we are – or been simply declared as irrelevant. The criteria of continuity and consistency have been dismissed as no longer attainable or even desirable in post-modern days in which patchwork identities or multiple selves are taken to mean a liberation from identity constraints. The sense of uniqueness is said to arise from emphasizing differences to others (e.g., by choosing unprecedented hobbies, interests, experiences).

The present study, in contrast, starts from the assumption that a sense of uniqueness is a 'necessary by-product', that is, a state that – like sleep, forgetting, happiness – is missed if directly pursued and attainable only as a concomitant consequence of intrinsically motivated commitments. From this assumption three hypotheses are derived:

1. Commitment is constitutive of identity.
2. Since commitment needs an object (e.g., a person, an idea, a project), content is requisite for identity.
3. What matters, however, is not the type of content chosen but the mode of appropriating it, that is, what matters is not that the project be matchless but be pursued in an autonomous way.

Procedure

174 17-year-old LOGIC-participants, 87 20- to 25-year-old university students (EXIST – **Ex**ploratory **I**dentity **St**udy), and 152 65- to 80-year-old GOLD-participants were asked to rate how different a person they would be if (list of various features) were different, followed by a 5-point scale ('I'd be exactly the same person' (1) … 'I'd be a totally different person' (5)), and to give justifications for those two features ascribed to exert highest or lowest impact on their identity. Additionally, EXIST-participants for the following vignettes had to judge whether they expected the protagonist to experience identity problems, and why.

- Cloning: X has successfully been cloned. Do X and his clone have the same identity?
- Greenpeace: Y is deeply committed to Greenpeace. At the same time he holds a top position in an atomic plant.
- Brainwashing: An ardent democrat is turned into a communist by brainwashing (situation taken from Nozick, 1981, *Philosophical explanations*, 27-114).
- '68: A strong adherent of the '68 student movement often protested against war and violence. Today he pleads for military interventions in emergencies.

Results and Interpretations

Commitment.

Figure 1 gives the percentage of participants attributing high personal importance to the features presented (scale values 4 and 5). There are differences between the age groups: More of the younger participants expect to be a different person under changed circumstances. This might reflect the fact that in the process of defining identity during adolescence, individuals experience themselves as more responsive to external influences. Nevertheless, there are clear convergencies: In all three age groups money, appearance, and personal interests (LOGIC)/choice of university major (EXIST)/occupation (GOLD) are attributed little identity relevance. In contrast, moral beliefs are seen as highly constitutive of one's personality. This latter finding is even strengthened by the fact that most participants justify the identity relevance of parents and sex-membership by referring to the norms and values they see connected with parental socialization styles and gender roles. There are also clear interindividual differences: Some participants assign a high value to appearance, most don't; some highly identify with their personal interests or occupational choices, others don't. The data show the identity relevance of commitments. Yet, counter to Giddens' claim, not all choices are important - participants decide which are. Most of them, however, rate their moral beliefs or ethical values as constitutive for their identity. This finding is supported by results in COHORT, showing that between 66 and 80% of the oldest participants hold on to the moral convictions developed or affirmed during their adolescent years although they know that many are no longer collectively accepted (Nunner-Winkler & Nikele, 2001)

Continuity, consistency, autonomy.

Responses to the vignettes in EXIST provide further clarifications. In the clone item no identity problems are expected – participants see identity as based on personal experiences, emotions, attitudes, that is, as autonomously constructed, not objectively determined by natural facts. About 4/5 expect problems in the brainwashing item but not in the '68 item. As they explain: In the first case the change of opinion had been enforced, while in the second case it was formed on rational grounds by implicit or explicit learning processes. More than half of the participants expected the Greenpeace member to experience identity problems for betraying his convictions, and many of those who did not, had discarded either the saliency of political attitudes or the intensity of the conflict (e.g., 'Maybe he works hard for improving safety standards in the atomic plant'). As these findings show, most participants see identity founded upon sociomoral persuasions – provided the person holds on to or changes them for good reasons (autonomy, continuity) and tries to translate them into action (consistency).

To conclude: Post-modern diagnoses of identity are misconstrued. In general, persons do not discard the postulate of consistency nor do they conceive of themselves as multiple selves, ever-changing as new lifestyle choices are made. Instead, they see themselves as autonomous agents taking a stance towards the different facets of their life and deciding how much they care about each of them. And most take their commitments to sociomoral values as constitutive of their identity - provided these are made autonomously.

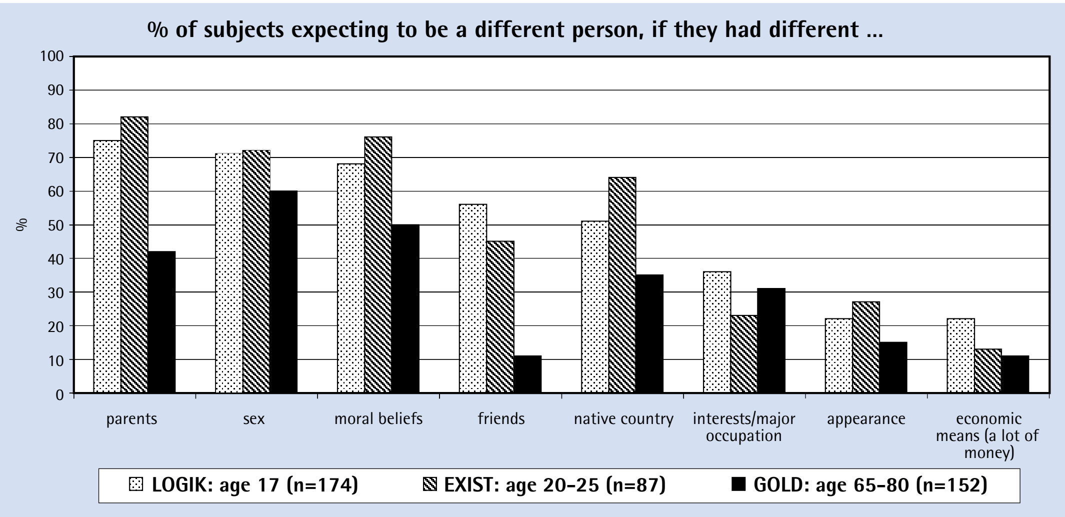

Figure 1: Percentage of 174 17-, and 87 20- to 30-, and 152 65- to 80-year-old participants attributing high identity relevance to the items given.

5. Moral Development

Project: Recognition of Moral Norms

This project is part of a compound of 17 research projects titled 'Promoting Social Integration in Modern Societies', which is financed by the German Ministry of Education and Research. For first results, see Report 'Recognition of Moral Norms', December 2003.

This study is based on the assumption that civic virtues are a functional prerequisite for the maintenance of constitutional democracies. This assumption is at variance with Luhmann's systems theory (1998, *Die Gesellschaft der Gesellschaft*), according to which in modern functionally differentiated societies normative integration is neither possible nor necessary. It agrees, however, with theories about deliberative democracy as proposed by Habermas (1992, *Faktizität und Geltung*) and with recent debates on the import of social capital, especially of shared norms. These, however, will be analyzed in a more differentiated manner. Starting point is the structural affinity between the basic principles of democratic constitutions and a contractualist reconstruction of a modern minimal morality which is clearly demarcated from religion or questions of the good life. Civic virtues (e.g., tolerance, sense of justice, taboo of private violence) are derived thereof and their recognition among young people is studied. Various problems may arise: In the *cognitive dimension* persons may deny the existence or justifiability of shared norms (moral relativism or scepticism); they may acquire norms that contradict basic democratic or moral principles (e.g., subordination of individual rights to a particularistically defined common good); they may favor conflicting interpretations of shared principles (e.g., differential rankings of justice criteria such as equality, equity, neediness); they may lack the competence for the context sensitive application of moral rules and principles (e.g., errors in judging the justifiability of exceptions). In the *motivational dimension* they might lack the willingness to abide by shared norms. Thus, there are quite distinct hazards for a democratic order: People might have an adequate understanding of the requisite norms, yet lack motivation to follow them – thus contributing to a process of gradual moral erosion. Or else, they might have high moral motivation yet be misguided in their cognitive understanding and – feeling their sense of justice thwarted - translate their self-righteous indignation into violent action. The early rise of the Nazi-movement from the moralistic resentment of the petite bourgeoisie (Moore, 1978, *Injustice*) illustrates this risk.

The present study addresses the practical problems that sparked the ministry's initiation of the research compound: Concerns about increasing nationalism and violence against foreigners, especially in the new German Länder. Its main focus, however, are theoretical issues dealt with in two different contexts - the debate on ethnocentrism and research on moral understanding.

Ethnocentrism.

Rejection of foreigners is accounted for in a variety of ways. In social psychology it is taken to reflect deficits in early socialization experience: the frustrations (produced by a rigidly controlling punitive father, by a negligent mother, by a parent abusing the child as substitute partner in case of marital disharmony, by the rigid discipline exerted in East-German public day-care centers) are aggressively turned against the powerless or translated into strategic behavior. Culturalist explanations refer to traditions of ethnic devaluations (e.g., a history of anti-semitism in Germany), to a destructive intolerance of ambiguity in modernity, to normative disintegration. Socioeconomic approaches point to rivalries for scarce jobs, cheap accommodation, and curtailed welfare supports. Also, political mistakes in the process of handling successive waves of immigration have been held responsible.

Moral understanding.

Without denying the relevance of these explanations, the present study focuses on the content of moral beliefs. The issue of universalism vs. particularism may serve to illustrate the core idea. Cultures differ in their definition of a universe of obligation. Thus, in ancient Greece all non-Greeks were classified as barbarians whom even Aristotle considered to be 'natural slaves'. In fact – as Weber (1956, *Wirtschaft und Gesellschaft*) noted – the differentiation between ingroup and outgroup morality is typical for traditional societies: "Behavior judged to be abominable 'among brothers' is accepted in dealing with strangers". Modern morality, in contrast, extends life integrity rights and respect for the person to all human beings. Explaining universalism in terms of shared cultural beliefs is at variance with Kohlberg's developmental theory assuming stage-specific expansions of the range of beings seen to deserve moral consideration. With its focus on the content of moral beliefs the present study continues previous attempts to disentangle the core dimensions that Kohlberg's theory confounds: moral motivation, sociocognitive development, substantive persuasions.

Ethnocentrism is a question not only of psychological deficits or economic competition but also of particularistic moral beliefs.

Hypotheses.

The hypotheses concern the independent effect of sociomoral beliefs on the development of civic virtues. The recent histories of the former FRG and GDR differ strongly. In the West democratic procedures and civic liberties were institutionalized; during the '60s, public debates on people's Nazi involvement led to a devaluation of nationalism; economic prosperity intensified processes of individualization. In the East a highly authoritarian regime repressed civic rights; dissociation from the NS-past resulted from official declarations, not from a self-reflective scrutiny of the people; economic scarcity led to an exchange trade which created extended social networks of reciprocal obligations. As a consequence, in the West a universalistic minimal morality evolved while in the East particularistic obligations may still have more weight. These may easily be misinterpreted on ethnocentric terms if active discrimination against outsiders comes to be seen as a mere supplement to legitimate ingroup preferences. In other words: Particularistic moral beliefs might be a factor in ethnocentrism - maybe an even more important one than personality deficits or economic competition. The testable hypothesis is: In the new countries even participants high in moral motivation and in sociocognitive development may display some degree of ethnocentrism, while in the old countries even participants low in moral motivation and in sociocognitive development will tend to hold universalistic attitudes.

Further hypotheses concern, on the one hand, the impact of other sociomoral beliefs (e.g., gender norms; moral relativism; concept of justice) and of sociocognitive development on the understanding of civic virtues and, on the other hand, the role early socialization experiences and the intensity of the adolescence crisis play for moral motivation.

Procedure

Sample: 203 15- to 16-year-old female and male participants were recruited from 8 Hauptschulen and 8 Gymnasien (i.e., from the lowest and highest educational tracks) in 4 German cities (2 from the West, 2 from the East). The 2- to 3-hour interviews included open-ended questions, hypothetical vignettes, standardized scales, and a simplified version of a prisoner's dilemma game. All responses were tape-recorded.

Present state: All interviews were conducted and transcribed and the standardized data entered into the computer. Presently, first exploratory statistical analysis are being performed on those data. On the basis of free responses to several moral conflicts, two researchers independently rated the strength of moral motivation on a 7-point scale (72 % exact agreement – remaining differences were resolved by discussion). The coding manual for the free responses is almost completed and for several topics questions have been coded.

First Results and Tentative Interpretations

Strength of moral motivation.

There are no differences between East- and West-German participants. Given that the growth of moral motivation is highly dependent on early socialization experiences, this finding questions the claim that the rigid disciplining in the East-German day-care centers is an important factor in explaining the higher incidence of ethnocentric attitudes in the new countries. There are clear differences between the sexes: The girls received higher ratings in moral motivation. The hypothesized connection to sex-role understanding still has to be explored.

Universalistic respect.

Participants high in moral motivation are significantly more likely to accord equal respect to members of various religious and ethnic groups than participants low in moral motivation. This supports the validity of the motivation ratings. Independent of the strength of moral motivation and of sociocognitive development, participants from the old German countries are much more likely to grant equal respect to all. This supports the basic assumption of the importance of culturally shared sociomoral beliefs.

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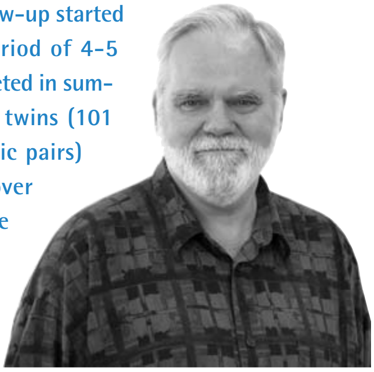
6. Differential Behavior Genetics

In October 1998, when Franz E. Weinert was appointed emeritus, the research unit "Differential Behavior Genetics" (Ulrich Geppert, Ernst A. Hany) was set up to continue the twin study GOLD (Genetically Oriented Lifespan Study of Differential Development). The study, which had started in 1995, was completed in spring 1999 (wave 5) with 191 pairs of twins. In summer 2000 a follow-up started with that sample after a period of 4-5 years (wave 6) and was completed in summer 2003 with 148 pairs of twins (101 monozygotic and 47 dizygotic pairs) who had traveled from all over Germany to Munich to take part. The mean age in the retest group increased from 70.8 to 75.3 years (age now varying from 68 to 88.5).



Ulrich Geppert

Ulrich Geppert (Coordinator)
Frank Halisch
Ernst A. Hany
Franz J. Neyer
Gertrud Nunner-Winkler

Over the past 20 years Franz Weinert's research unit carried out two longitudinal studies (LOGIC, SCHOLASTIC) that revealed large individual differences in child development. These differences proved to be very stable across time. Thus, research interest grew with respect to two issues: (1) Do individual differences remain stable beyond childhood in adult and old people? (2) To what extent are inherited and early individual conditions responsible for the observed stability in individual differences? The pursuit of these research goals was facilitated by the fact that in 1991, Kurt Gottschaldt had willed the data from his longitudinal twin study to our institute. Gottschaldt had run his study from 1937 to 1968 in three waves. In 1992-1993 a fourth wave was carried out at the Max Planck Institute, with 33 of the original 90 pairs from 1937. The decision to continue the study required to extend the small sample size in order to meet the theoretical and methodological standards of modern behavioral genetics. The GOLD study running since 1995 (wave 5) was able to recruit 171 new pairs of twins aged 63 to 85 years to join the surviving Gottschaldt pairs who were numerically reduced to 20 in wave 5 and to 15 pairs in wave 6.

The research questions of wave 5 (age comparisons, longitudinal analyses, heritability estimations) required a multitude of tasks, tests, questionnaires, and interviews covering developmental domains such as basic cognitive processes and intellectual abilities, learning and memory, motivation and emotion, personality, moral understanding, and social relations. Respective results, with the focus on single developmental domains mainly of wave 5, have already been published (Geppert & Halisch, 2001; Geppert & Hany, 2003; Neyer & Lang, 2003; Nunner-Winkler & Nikele, 2001; Weinert & Hany, 2003). A more comprehensive overview will be published in a book that the former collaborators of the GOLD study are preparing for 2004.

The additional retest of the entire twin sample with the opportunity to compare waves 5 and 6 enables the study of individual change and an examination of aging processes. Having just completed wave 6, data control is still in progress, however. Thus, only provisional results of longitudinal change between wave 5 and 6 can be presented here.

Elementary Cognitive Processes

At higher age, mental performance changes substantially within a few years. The observing of changes enables us to search for conditions and causes of the general and differential changes. In accordance with the theory of fluid intelligence and the model of age-related "general slowing" of all cognitive functions, we expected age-related reduction of perceptual speed in particular. In fact, substantial age effects emerged in measures of visual search (using Anne Treisman's paradigm; Treisman, 1992, *Am Psychologist, 47,* 862-75) even within a span of 4.5 years (Figure 1). Age effects were observed in the search for both a single feature (looking for a red X among green X's or among red O's) and a conjunction of features (looking for a red X among green X's and red O's). As expected, feature search allows for parallel scanning of the visual field with search time being independent of the number of visual elements. In contrast, conjunction search requires a serial evaluation of each element with search reaction time depending on the

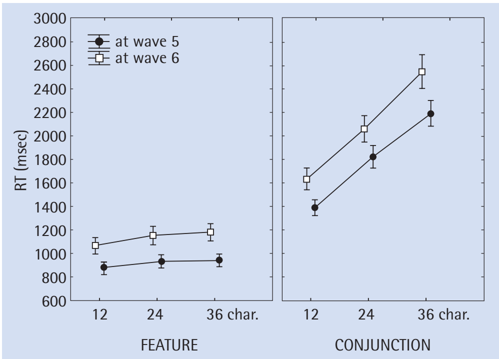


Figure 1: Mean RTs of participants at age 70.4 and 74.9 (longitudinal data) for a visual search task (feature and conjunction search are compared; the visual field consisted of 12, 24, or 36 elements).

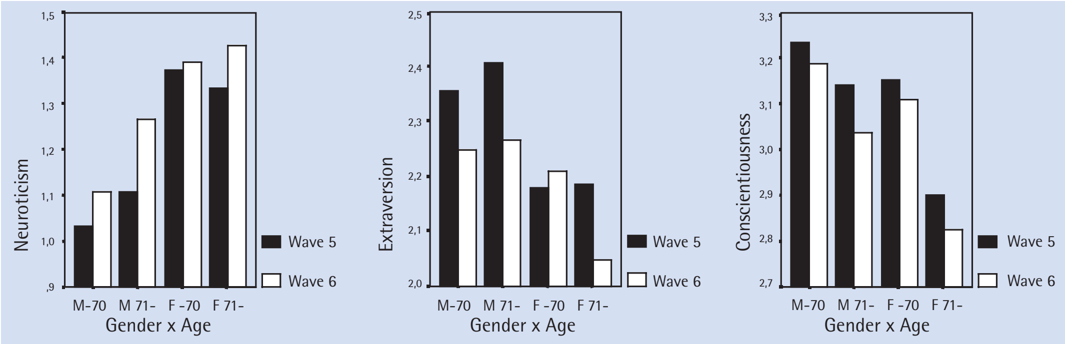


Figure 2: Developmental change in personality characteristics as a function of gender and age.

number of elements. Both kinds of search seem to be intact at older age. The significant interaction of time of measurement (age) and number of visual elements indicated a proportional slowing factor to be in effect.

Other preliminary results confirm insights provided by Paul Baltes and Reinhold Kliegl (1992, *Dev Psychology, 28,* 121-25) who have found that training deficit causes older people to work quite below their maximum performance level. With some effort of training, memory as well as reasoning skills can be preserved until old age, as Willis and Schaie (1994, in Forette et al., *Plasticité cérebrale et stimulation cognitive,* 91-113) have demonstrated, too. Therefore, many cognitive age differences that have been reported in the literature must be considered with caution. Lack of training and familiarity – particularly with achievement contexts that emphasize fast reaction times (which has gained importance in our computer society only recently) – may make cognitive age differences appear larger than the underlying learning potential really is.

Personality Characteristics

Although much research has been done on adult personality development over the life span, most studies focused on changes from adolescence to adulthood or from middle to advanced age, that is, on the transition to retirement. For the age span of 65 to 85 there is only scarce evidence from other studies. The basic question is whether there is a substantial change in old age at all or whether personality characteristics remain stable after having reached a certain level. As to the Big-Five factors neuroticism, extraversion, openness, agreeableness, and conscientiousness, for example, the general findings of high stability and little change over age lead to maintain that from the age of 30 onwards the stability of personality traits undergoes no more change in most cases. Cross-sectional results with the German Big-Five version point to lower neuroticism, extraversion and openness values in older adults, and higher values for agreeableness and conscientiousness. Yet, probably, there is less intra-individual change than cross-sectional results suggest.

In contrast, our cross-sectional results of wave 5 comparing two age groups of 63 - 70 (-70) and 71 - 85 (71-) depicted only one age effect in conscientiousness: the older were less conscientious than the younger ones. However, in the longitudinal study (see Figure 2) neuroticism increased, and extraversion and conscientiousness decreased within about five years, although stability of all traits was high (r= .65 to .70). Besides the main effect of change there are also gender differences: males (M) are less neurotic, more extraverted and more conscientious than females (F). And one main effect of age is found again that confirms the cross-sectional result for both waves: the younger are more conscientious than the older ones.

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Appendix

Page

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Vierkant, T. (2003, November). *Spontaneität und willentliche Handlungen [Spontaneity and Voluntary Action].* Max-Planck-Institut für Psychologische Forschung, München.

Vierkant, T., & Vossenkuhl, W. (2003, February). *Munich Philosophical Lecture Series on the Nature and Culture of Volition.* Max-Planck-Institut für Psychologische Forschung, München.

Walde, B., & Vierkant, T. (2001, October – July, 2002). *Willenshandlungen und Willensfreiheit. Kolloquiumsreihe [Voluntary Action and Free Will. Colloquium].* Max-Planck-Institut für Psychologische Forschung, München.

Munich Encounters in Cognition and Action (MECA)

The cognition-action interplay has long been neglected in the behavioral and brain sciences. In psychology and physiology, perception and cognition and, to a lesser degree, movement and action have always been broadly studied topics, but the interactions between these domains were not systematically explored. In recent years, however, new approaches and paradigms have been developed and allow for novel insights. Twice a year, our Munich Encounters focus on particular themes from the field of the interactions between cognition and action, bringing together a number of leading researchers who have made significant contributions to the field.

Cognition and Action in Social Life (May 2001)
organized by Günther Knoblich, Iring Koch, Sabine Maasen & Wolfgang Prinz

Early Development of Action Control (November 2001)
organized by Gisa Aschersleben & Birgit Elsner

Anticipation in Cognition and Action (April 2002)
organized by Andreas Wohlschläger & Ralf Möller

Approaches to Conscious Awareness (December 2002)
organized by Edmund Wascher

Bimanual Coordination – How the Hands Work Together (May 2003)
organized by Franz Mechsner & Martina Rieger

Linking Language to Action (November 2003)
organized by Marc Grosjean & Günther Knoblich

Contributions to Congresses and Invited Lectures

A

Angele, S., Wolber, M., & Wascher, E. (2001, April). *Der Simon-Effekt bei Greifbewegungen: Eine EEG-Studie [The Simon effect with grasping movements: An EEG-study].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Aschersleben, G. (2001, May). *Early development of the cognitive control of action planning: Some theoretical considerations.* Workshop 'Issues in Early Development of Perception and Action', München.

Aschersleben, G. (2001, October). *Die Rolle sensorischer Konsequenzen bei der zeitlichen Steuerung von Handlungen [The role of sensory consequences in the temporal control of movements].* Institut für Allgemeine Psychologie, Universität Leipzig.

Aschersleben, G. (2002, May). *Neue Perspektiven der Wahrnehmungspsychologie am Beispiel räumlicher und zeitlicher Dissoziationen [New perspectives in perceptual psychology with spatial and temporal dissociations as examples].* Institut für Psychologie, Leopold-Franzens-Universität, Innsbruck, Austria.

Aschersleben, G. (2002, June). *Wahrnehmung im Dienste der Handlungssteuerung [Perception for action control].* Institut für Kognitionsforschung, Universität Oldenburg.

Aschersleben, G. (2002, July). *The role of effects in infants' perception of action goals.* Workshop 'Infant Action Understanding', München.

Aschersleben, G. (2002, July). *Zeitliche Dissoziationen zwischen Wahrnehmung und Handlungssteuerung [Temporal dissociations in perception and action control].* Wissenschaftsbereich Psychologie, Freie Universität Berlin.

Aschersleben, G. (2002, October). *Action timing. Intersensory integration of action effects.* School of Humanities and Social Sciences, International University Bremen.

Aschersleben, G. (2003, February). *Die Rolle von Handlungseffekten bei der Steuerung von Handlungen [The role of action effects in action control].* Institut für Psychologie, Friedrich-Schiller-Universität, Jena.

Aschersleben, G., Elsner, B., & Hauf, P. (2003, September). *Die Rolle von Handlungseffekten bei der frühkindlichen Imitation [The role of action effects in infant imitation].* 16. Tagung Entwicklungspsychologie, Mainz.

Aschersleben, G., & Hauf, P. (2003, November). *Welche Rolle spielen Handlungseffekte bei der frühkindlichen Handlungssteuerung? [The role of action effects in infant action control].* 36. Herbsttagung experimentelle Kognitionspsychologie, Erlangen.

Aschersleben, G., Jovanovic, B., & Elsner, B. (2001, September). *The influence of action effects on the perception of action goals in infants.* 5. Fachtagung der Gesellschaft für Kognitionswissenschaft, Leipzig.

B

Bach, P. (2002, July). *Comprehension of transitive actions.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kochel.

Bach, P., Gunter, T. C., Knoblich, G., Prinz, W., & Friederici, A. D. (2002, March). *Verarbeitung von Struktur und Bedeutung beim Handlungsverstehen [Processing of structure and meaning in action comprehension].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Bach, P., Knoblich, G., Gunter, T. C., Friederici, A. D., & Prinz, W. (2002, September). *Integration von Struktur und Bedeutung bei einfachen Handlungen [Integrating the structure and meaning of simple actions].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Bach, P., Knoblich, G., Gunter, T. C., Friederici, A. D., & Prinz, W. (2003, September). *Conceptual and structural relations in action comprehension.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Bach, P., Knoblich, G., & Prinz, W. (2001, April). *Prozesse des Handlungsverstehens [Processes in action comprehension].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Begliomini, C., & Koch, I. (2003, March). *Stimulus-response compatibility effects in cued dual-task paradigms.* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Bekkering, H. (2001, June). *Imitation: Normal and pathological control of action.* Annual Meeting of Theoretical & Experimental Neuropsychology (TENNET), Montreal, Canada.

Berndt, I., Wascher, E., Franz, V. H., Götz, K. G., & Bülthoff, H. H. (2001, February). *Lateralisierungen der hirnelektrischen Aktivität während Zeigebewegungen mit gespiegeltem Blickfeld [Lateralisations of cortical electrophysiological activity during pointing movements with mirrored visual gaze].* 4. Tübinger Wahrnehmungskonferenz (TWK 2001), Tübingen.

Bertelson, P., & Aschersleben, G. (2003, November). *Temporal ventriloquism: Apparent attraction of visual by auditory inputs on the time dimension.* 44th Annual Meeting of the Psychonomic Society, Vancouver, Canada.

Biesenbender, V., & Mechsner, F. (2003, November). *Kunst und Wissenschaft der Bewegung.* Art and science of movement, Hanse-Wissenschaftskolleg, Delmenhorst.

Bosbach, S. (2002, June). *Über Wahrnehmung und Handlung - Konflikte zwischen bewussten und unbewussten Prozessen als Evidenz für eine funktionale Verbindung zwischen Wahrnehmung und Handlung [About perception and action - Conflicts of conscious and unconscious processes as evidence for a functional relationship between perception and action].* Universitätsklinikum Ulm, Abteilung für Psychiatrie, Ulm.

Bosbach, S., Kerzel, D., & Prinz, W. (2001, August). *No attention-shift, no Simon-effect? Exploring the role of attention in spatial stimulus-response compatibility.* Tutorials in Behavioural and Brain Sciences (TuBBS), Nijmegen, NL.

Bosbach, S., Kerzel, D., & Prinz, W. (2002, March). *Is direction position? Position- and direction-based compatibility effects in tasks with dynamic displays.* Interdisziplinäres Kolleg 2002, Günne am Möhnesee.

Bosbach, S., Kerzel, D., & Prinz, W. (2002, March). *Visuelle Bewegungswahrnehmung und der Simon-Effekt [Visual motion perception and the Simon-effect].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Bosbach, S., Kerzel, D., & Prinz, W. (2002, July). *On things that go and do not go together: Effects of stimulus-response compatibility in tasks with dynamic displays.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kochel.

Bosbach, S., Kerzel, D., & Prinz, W. (2002, September). *Belege für eine funktionale Verbindung von Wahrnehmung und Handlung - Kompatibilitätseffekte bei bewegten Reizen [Evidence for functional relationship between perception and action - Compatibility effects in tasks with moving stimuli].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Bosbach, S., Kerzel, D., & Prinz, W. (2002, September). *Evidence for a functional relationship between perception and action: Compatibility effects in tasks with moving stimuli.* EuroConference and EBBS workshop on Cognitive and Neural Mechanisms of Visuomotor Control, La Londe, France.

Bosbach, S., Kerzel, D., & Prinz, W. (2002, November). *Visual motion perception and the Simon-effect.* 43rd Annual Meeting of the Psychonomic Society, Kansas City, MO.

Bosbach, S., Prinz, W., & Kerzel, D. (2003, March). *Simon-Effekte bei stationär bewegten Reizen [Simon-effects with stationary moving stimuli].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Bosbach, S., Prinz, W., & Kerzel, D. (2003, May). *Der Simon-Effekt bei stationär bewegten Reizen [The Simon-effect with stationary moving stimuli].* Justus-Liebig Universität, Giessen.

Bosbach, S., Prinz, W., & Kerzel, D. (2003, September). *The influence of visual motion perception on action control.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Brosda, S., Laboissière, R., & Abry, C. (2001, October). *Grounding productive phonology in speech physiology: Canonical babbling or the discovery of speech-like production.* Laboratoire de Sciences Cognitives et Psycholinguistique EHESS/CNRS, Marseille, France.

Buhlmann, I., & Wascher, E. (2003, March). *Der Einfluss von Hinweisreizen auf die Verarbeitung vertikaler Simon Aufgaben [The influence of cueing stimuli on the processing in vertical Simon tasks].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

D

Danielmaier, C., Zysset, S., & Müsseler, J. (2002, July). *Whether and how action impairs perception – the blindness effect in an event-related fMRI study.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kochel.

Danielmaier, C., Zysset, S., Müsseler, J., & von Cramon, D. Y. (2003, March). *Action impairs visual encoding - an event-related fMRI study.* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

de Maeght, S. (2001, October). *New insights in ideomotor action: Investigating the influence of motor representations.* Forschungskolloquium 'Theoretische und Experimentelle Kognitionspsychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

de Maeght, S., Knuf, L., & Prinz, W. (2001, March). *The necessity of biological motion in ideomotor movements.* Symposium 'Neural control of space coding and action production', Lyon, France.

de Maeght, S., Knuf, L., & Prinz, W. (2001, May). *The observation of steering movements modulates ideomotor action.* Meeting of the Belgian Psychological Society, Louvain-La-Neuve, Belgium.

Deubzer, E. M., & Aschersleben, G. (2001, April). *Wie muss eine nutzerorientierte Anordnung von Objekten im Raum aussehen? [How should a user-friendly arrangement of objects look like?].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Drewing, K. (2001, April). *Bimanuelle Kopplung und taktile Reafferenzen [Bimanual coupling and tactile reafference].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Drewing, K. (2001, June). *Die Rolle sensorischer Reafferenzen bei der zeitlichen Steuerung bimanueller Bewegungen [A role for sensory reafference in the timing of bimanual movements].* Forschungskolloquium 'Theoretische und experimentelle Kognitionspsychologie', Ludwig-Maximilians-Universität, München.

Drewing, K. (2001, July). *Ein Beitrag sensorischer Reafferenz zur zeitlichen Steuerung von Handlungen [A contribution of sensory reafference to the timing of actions].* Abteilung Allgemeine Psychologie, Technische Universität Braunschweig.

Drewing, K. (2002, February). *Sensorimotor synchronization across the life span.* Max-Planck-Institut für Bildungsforschung, Berlin.

Drewing, K., & Aschersleben, G. (2001, September). *A role for tactile reafferences in bimanual finger tapping.* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

Drewing, K., Li, S., & Aschersleben, G. (2002, March). *Entwicklung sensumotorischer Synchronisationsleistung über die Lebensspanne [Development of performance in sensorimotor synchronization across the life span].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Drewing, K., Li, S., & Aschersleben, G. (2002, June). *Sensorimotor synchronization across the life span.* International Congress 'Movement, Attention & Perception', Université de Poitiers, France.

Drewing, K., Stenneken, P., Cole, J., & Aschersleben, G. (2003, March). *Die zeitliche Steuerung bimanueller Bewegungen bei einem deafferentierten Probanden [Timing of bimanual movements in a deafferented person].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Drost, U. C., Knoblich, G., & Goschke, T. (2001, April). *Koordination konfligierender Handlungen [Coordination of conflicting actions].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Drost, U. C., & Rieger, M. (2002, September). *Effektbezogene Handlungssteuerung bei Musikern [Effect-based action control in musicians].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Drost, U. C., Rieger, M., Braß, M., & Gunter, T. C. (2003, March). *Handlungs-Effekt-Beziehungen bei Pianisten [Action-effect relations in pianists].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Drost, U. C., Rieger, M., Braß, M., Gunter, T. C., & Prinz, W. (2003, September). *Motor-related chord representations in musical experts.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Drost, U. C., Rieger, M., Braß, M., Gunter, T. C., & Prinz, W. (2003, November). *Instrument-specific action-effect associations in experienced piano and guitar players.* 44th Annual Meeting of the Psychonomic Society, Vancouver, Canada.

E

Elsner, B. (2001, May). *The role of temporal contiguity and conditional probability in adults' learning about action outcomes.* Workshop 'Issues in Early Development of Perception and Action', München.

Elsner, B. (2001, June). *Der Erwerb kognitiver Handlungsrepräsentationen [Acquiring cognitive representations of actions].* Dissertationswettbewerb der Fachgruppe Allgemeine Psychologie der Deutschen Gesellschaft für Psychologie, München.

Elsner, B. (2001, July). *Die Verknüpfung von Handlungen und ihren Konsequenzen im menschlichen Gehirn - eine $H_2{}^{15}O$-PET-Studie [Linking actions and their perceivable consequences in the human brain: a $H_2{}^{15}O$-PET study].* Ludwig-Maximilians-Universität, München.

Elsner, B. (2001, November). *Imitation von Handlungssequenzen bei 6 und 12 Monate alten Kindern [Imitation of action sequences in 6- to 12-month-old infants].* Ludwig-Maximilians-Universität, München.

Elsner, B. (2002, May). *Imitative learning of movement-effect contingencies around the 1st birthday.* Conference 'Perspectives on imitation: From cognitive neuroscience to social science', Abbaye de Royaumont, France.

Elsner, B. (2003, May). *Infants in action: How relations between movements and effects are learned in the first two years of life.* University of Leiden, Cognitive Psychology Section, Leiden, NL.

Elsner, B., & Aschersleben, G. (2002, April). *Observational learning of contingencies between movements and their perceivable consequences around the 1st birthday.* 13th Biennial International Conference on Infant Studies (ICIS 2002), Toronto, Canada.

Elsner, B., & Aschersleben, G. (2002, June). *Do infants learn by observation?* EURESCO Conference 'Brain Development and Cognition', Acquafredda di Maratea, Italy.

Elsner, B., & Aschersleben, G. (2002, October). *Learning about the effects of self- and other-performed actions in infancy.* Symposium 'Self and Action', Ohlstadt.

Contributions to Congresses and Invited Lectures

Elsner, B., & Aschersleben, G. (2003, April). *Infants' imitation of action sequences: Not only a memory problem!* Biennial Meeting of the Society for Research in Child Development, Tampa, FL.

Elsner, B., & Aschersleben, G. (2003, September). *Verständnis für die Effekte von Handlungen in der frühen Kindheit [How infants understand the effects of actions].* 16. Tagung Entwicklungspsychologie, Mainz.

Elsner, B., Hauf, P., & Aschersleben, G. (2003, September). *Imitation von Handlungssequenzen in der frühen Kindheit: nur ein Gedächtnisproblem? [Imitation of action sequences in infancy: Only a memory problem?].* 16. Tagung Entwicklungspsychologie, Mainz.

Elsner, B., & Hommel, B. (2003, September). *How action effects are converted into action goals: Evidence from behavioral and PET studies.* 35th Annual General Meeting of the European Brain and Behaviour Society, Barcelona, Spain.

Elsner, B., Hommel, B., Mentschel, C., Drzezga, A., Prinz, W., Conrad, B., et al. (2001, November). *Linking actions and their perceivable consequences in the human brain.* 42nd Annual Meeting of the Psychonomic Society, Orlando, FL.

Elsner, B., Hommel, B., & Siebner, H. R. (2001, February). *Neuronale Aktivierung durch die Wahrnehmung erlernter Handlungskonsequenzen [Neural activation through the perception of learnt action consequences].* Workshop 'Neurologie' (MEG Düsseldorf - MPI für psychologische Forschung München), Düsseldorf.

Elsner, B., Hommel, B., & Siebner, H. R. (2001, March). *The perception of learned action consequences activates motor representations: A PET study.* Symposium 'Principles of Human Learning and Memory, Delmenhorst.

Elsner, B., Hommel, B., & Siebner, H. R. (2001, June). *Retrieving associations of actions and their sensory consequences: A PET study.* 7th Annual Meeting of the Organization for Human Brain Mapping (HBM 2001), Brighton, UK.

Elsner, B., Peller, M., Erhard, P., & Siebner, H. R. (2001, December). *fMRT-Untersuchung zur Neuroanatomie von Handlungseffekten [A fMRT study of the neuronal basis of action effects].* Klinikum rechts der Isar, München.

Elsner, B., Siebner, H. R., & Hommel, B. (2001, April). *Neuronale Aktivierung durch die Wahrnehmung eines erlernten Handlungseffekts [Neural activation by the perception of a learned action effect].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Elsner, B., Siebner, H. R., & Hommel, B. (2001, September). *Brain structures representing learned associations between actions and their sensory consequences: A $H_2{}^{15}O$-PET study.* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

F

Flach, R. (2001, April). *Die Rolle impliziter motorischer Kompetenzen in der zeitlichen Antizipation [The role of implicit motor competencies in temporal anticipation].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Flach, R. (2001, August). *Auditory cues in self-recognition.* Tutorials in Behavioural and Brain Sciences (TuBBS), Nijmegen, NL.

Flach, R. (2002, March). *The 2/3 power law in motion perception: When motor anticipations come into play.* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Flach, R. (2003, May). *Zur Spezifität der Handlungswahrnehmung: Einige Überlegungen und Befunde [On the specificity of action perception: Some deliberations and findings].* Forschungskolloquium 'Allgemeine und Experimentelle Psychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

Forstmann, B., Koch, I., Braß, M., & von Cramon, D. Y. (2003, March). *Comparing different cue types in task switching.* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

G

Geppert, U. (2001, September). *Leistungsthematische Emotionen im Alter [Achievement related emotions in old age].* 15. Tagung Entwicklungspsychologie, Potsdam.

Geppert, U. (2002, July). *Expressive behavior as a reaction to success and failure: Readout of a self-evaluative state or social signal?* 12th Conference of the International Society for Research on Emotion, Cuenca, Spain.

Geppert, U. (2002, September). *Sind interindividuelle Unterschiede in Persönlichkeitsdispositionen hauptsächlich genetisch bedingt? Heritabilitätsschätzungen von Eigenschaften und Motiven [Are individual differences in personality dispositions mainly genetically determined? Heredity estimations of traits and motives].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Geppert, U. (2003, September). *Heritabilität individueller Unterschiede in globalen und spezifischen Persönlichkeitsmerkmalen: direkte und vermittelte Beeinflussung durch Anlage und Umwelt [Heredity of individual differences in global and specific personality characteristics: Direct and mediated influence of nature and nurture].* 16. Tagung Entwicklungspsychologie, Mainz.

Geppert, U. (2003, September). *Ziele der 'Genetisch orientierten Lebensspannenstudie.' Anmerkungen zur Stichprobe [Goals of the 'Genetic oriented life span study.' Remarks on the sample].* 16. Tagung Entwicklungspsychologie, Mainz.

Geppert, U., & Halisch, F. (2002, June). *Genetic and environmental determination of personality: Traits versus motives.* 8th Workshop on Achievement and Task Motivation (WATM), Moskau.

Geppert, U., & Hany, E. A. (2002, February). *Lebenslange Entwicklung und Verhaltensgenese [Lifelong development and the foundation of behavior].* Symposium zum Gedenken an Franz E. Weinert 'Entwicklung, Lehren und Lernen', München.

Goschke, T. (2001, January). *Kognitive Grundlagen der Handlungssteuerung: Zur experimentellen Dekomposition exekutiver Funktionen [Cognitive foundations of action control: Experimental decomposition of executive functions].* Westfälische Wilhelms-Universität, Münster.

Goschke, T. (2001, April). *Implicit learning in domain-specific representation systems: Independent acquisition of spatiomotor and nonspatial sequences.* 8th Annual Meeting of the Cognitive Neuroscience Society, New York, NY.

Goschke, T. (2001, April). *Implizites Lernen: Von Dissoziationen zu Funktionsprinzipien [Implicit learning: From dissociations to functional principles].* Ernst-Moritz-Arndt-Universität, Greifswald.

Goschke, T. (2001, May). *Voluntary action and cognitive control: Antagonistic constraints and complementary control functions.* Colloquium 'Control of Cognitive Processes', Netherlands Royal Academy of Science, Amsterdam, NL.

Goschke, T. (2002, February). *Implizites Lernen sequentieller Strukturen: Von Dissoziation zu Funktionsprinzipien [Implicit learning of sequential structures: From dissociations to functional principles].* Universität Göttingen.

Goschke, T. (2002, July). *Conflict and control: Dynamic regulation of flexibility and persistence.* International Symposium on Executive Functions: The interaction of endogenous and exogenous mechanisms for the control of action, Universität Konstanz.

Goschke, T. (2002, July). *Kognition, Lernen und Handlungssteuerung: Antagonistische Funktionen und komplementäre Systeme [Cognition, learning, and action control: Antagonistic functions and complementary systems].* Universität Erlangen-Nürnberg.

Goschke, T. (2002, August). *Implicit learning in domain-specific representation systems: Independent acquisition of spatial and phonological sequences.* International Symposium 'Assessing the Dynamics of Brain Functions', Universität Marburg.

Goschke, T. (2002, October). *Implizites Lernen und unbewusstes Wissen.* Symposium 'turmdersinne 2002': Vom Nürnberger Trichter zum neuronalen Netz - Lernen und Gehirn, Nürnberg.

Goschke, T. (2002, November). *Dilemmas of the mind: Antagonistic constraints and complementary systems in cognition and action.* International Symposium 'Logic and Creativity - Integrating Categorial Rules and Experience', Universität Osnabrück.

Goschke, T. (2003, February). *Unconscious determinants of the conscious experience of voluntary control.* Munich Philosophical Lecture Series on the Nature and Culture of Volition, Max-Planck-Institut für Psychologische Forschung, München.

Goschke, T. (2003, April). *Konflikt, Affekt und Kontrolle: Dynamische Regulation von kognitiver Flexibilität und Stabilität.* Symposium 'Conflict, affect,and control: Dynamic regulation of cognitive flexibility and stability', Technische Universität, Braunschweig.

Goschke, T. (2003, July). *Emotional modulation of cognitive flexibility and stability.* Annual Meeting of the European Society for Philosophy and Psychology, Fondatione Roselli, Torino, Italy.

Goschke, T., & Gruber, O. (2002, June). *Dynamic regulation of complementary cognitive control processes.* Arbeitstreffen DFG-Schwerpunktptogramm 1107 'Executive Functions', Herrsching am Ammersee.

Goschke, T., & Gruber, O. (2002, December). *Dynamic interactions between complementary components of cognitive control.* Arbeitstreffen DFG-Schwerpunktptogramm 1107 'Executive Functions', Max-Planck-Institut für neuropsychologische Forschung, Leipzig.

Goschke, T., Gruber, O., & Karch, S. (2003, July). *Dynamic interactions between complementary components of cognitive control.* Arbeitstreffen DFG-Schwerpunktptogramm 1107 'Executive Functions', Fulda.

Grosjean, M. (2001, May). *Temporal stimulus-response compatibility: Going beyond traditional measures of performance.* Max-Planck-Institut für Psychologische Forschung, München.

Grosjean, M. (2002, June). *Action preparation and object recognition: A potential solution to an existing conflict.* Psychologisches Institut, Universität Würzburg.

Grosjean, M. (2003, April). *La préparation à l'action et son influence sur le traitement perceptif [The influence of action preparation on perceptual processing].* UMR 'Movement and Perception', Faculty of Sport Sciences, University of the Mediterranean and CNRS, Marseilles, France.

Grosjean, M., & Mordkoff, J. T. (2001, April). *Further evidence of action-effect integration from the Simon task.* 4th Annual Perception and Attention Mini-Conference held in conjunction with the 72nd Annual Meeting of the Eastern Psychological Association, Washington, DC.

Grosjean, M., & Mordkoff, J. T. (2001, May). *On the influence of motor preparation on perceptual processing.* 1st Annual Meeting of the Vision Sciences Society, Sarasota, FL.

Grosjean, M., & Mordkoff, J. T. (2002, November). *Motor preparation and perceptual processing: A potential solution to an existing conflict.* 43rd Annual Meeting of the Psychonomic Society, Kansas City, MO.

Grosjean, M., & Prinz, W. (2003, September). *Acting while perceiving functionally unrelated events.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Grosjean, M., & Prinz, W. (2003, November). *Interactions between concurrently perceiving and producing functionally unrelated events.* 44th Annual Meeting of the Psychonomic Society, Vancouver, Canada.

Gunter, T. C., Knoblich, G., Bach, P., Prinz, W., & Friederici, A. D. (2002, April). *Meaning and structure in action comprehension: Electrophysiological evidence.* 9th Annual Meeting of the Cognitive Neuroscience Society, San Francisco, CA.

Gunter, T. C., Nakamura, A., & Bach, P. (2003, March). *Communicating hands: ERPs elicited by meaningful symbolic hand postures.* 10th Annual Meeting of the Cognitive Neuroscience Society, New York, NY.

H

Hauf, P. (2002, January). *Die frühkindlichen Grundlagen der Handlungswahrnehmung [Basic principles of action perception in infancy].* Institut für Psychologie, Johann Wolfgang Goethe-Universität, Frankfurt.

Hauf, P. (2002, January). *Perzeptiv-kognitives Wahlverhalten in der mehrdimensionalen Psychophysik: Human- und Animaldaten im Vergleich [Perceptual-cognitive choice behavior in multidimensional psychophysics: Comparison of human and animal data].* Arbeitsheinheit Biopsychologie, Fakultät für Psychologie, Ruhr-Universität Bochum.

Hauf, P. (2002, February). *Perzeptiv-kognitives Wahlverhalten in der mehrdimensionalen Psychophysik: Alterspezifische Größenurteile in Abhängigkeit von Farbe und Helligkeit [Perceptual-cognitive choice behavoir in multidimensional psychophysics: Age-related judgments of size in combination with color or brightness].* Friedrich-Miescher-Laboratorium der Max-Planck-Gesellschaft, Tübingen.

Hauf, P. (2003, April). *Age-related development of multidimensional judgment types depending on different stimulus dimensions.* Biennial Meeting of the Society for Research in Child Development, Tampa, FL.

Hauf, P. (2003, October). *The role of action effects in infants' action perception and action production.* Department of Psychology, University of Illinois, Champaign, IL.

Hauf, P., Elsner, B., & Aschersleben, G. (2002, May). *Three-step actions: Developmental changes in delayed imitation by 9- to 15-month-old infants.* Conference 'Perspectives on imitation: From cognitive neuroscience to social science', Abbaye de Royaumont, France.

Hauf, P., Elsner, B., & Aschersleben, G. (2002, September). *Altersabhängige Entwicklung der Imitation von 'Drei-Schritt-Handlungen' bei Kleinkindern (9-15 Mon.) [Age-dependent development of imitation of three-step actions in infants (9 to 15 months of age)].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Hauf, P., Prinz, W., & Aschersleben, G. (2003, May). *'You-like-Me' or 'Me-like-You'? - The understanding of own and others' actions around the 1st birthday.* Biennial Meeting of the Society for Research in Child Development, Tampa, FL.

Hauf, P., Prinz, W., & Aschersleben, G. (2003, June). *The perception of others' action in 9-month-old infants.* 9th Meeting of the Child Vision Research Society, Göteborg, Sweden.

Hauf, P., Prinz, W., & Aschersleben, G. (2003, August). *Perception of others' actions and production of own actions in 9- and 11-month-old infants.* XIth European Conference on Developmental Psychology, University of Milano, Milano, Italy.

Hauf, P., Prinz, W., & Aschersleben, G. (2003, September). *'You-like-Me' oder 'Me-like-You'? - Wie verstehen Kinder im ersten Lebensjahr eigene und fremde Handlungen ['You-like-Me' oder 'Me-like-You'? - How do infants understand self- and other-performed actions during the first year of life?].* 16. Tagung Entwicklungspsychologie, Mainz.

Hauf, P., Prior, H., & Sarris, V. (2002, August). *Perceptual relativity: Effects of absolute and relative training on color and size discrimination in baby chickens.* 1st European Conference on Behavioral Biology, Münster.

Hauf, P., & Sarris, V. (2001, October). *The 'four stimulus - two choice'-paradigm in multidimensional psychophysics: Size, color, and brightness dimensions combined.* 17th Annual Meeting of the International Society for Psychophysics (Fechner Day), Leipzig.

Contributions to Congresses and Invited Lectures

Hofer, T., Hauf, P., & Aschersleben, G. (2003, March). *Die Rolle von Handlungseffekten für die Wahrnehmung von Zielgerichtetheit bei Säuglingen [The role of action effects for the perception of goal-directedness].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Hofer, T., Hauf, P., & Aschersleben, G. (2003, July). *Infant's perception of goal-directed actions performed by a mechanical claw.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kloster Nimbschen, Grimma.

Hofer, T., Hauf, P., & Aschersleben, G. (2003, August). *The role of action effects in the perception of goal-directed actions in infants.* XIth European Conference on Developmental Psychology, University of Milano, Milano, Italy.

Hofer, T., Hauf, P., & Aschersleben, G. (2003, September). *Die Rolle des Agenten für die Wahrnehmung von zielgerichteten Handlungen bei Säuglingen [Agent's role for the perception of goal-directed actions in infancy].* 16. Tagung Entwicklungspsychologie, Mainz.

Hoffmann, H. (2002, November). *Internal models in a robot environment.* Lehrstuhl für BioMolekulare Optik, Ludwig-Maximilians-Universität, München.

Hoffmann, H., & Möller, R. (2003, June). *Unsupervised learning of a kinematic arm model.* Joint 13th International Conference on Artificial Neural Networks & 10th International Conference on Neural Information Processing (ICANN/ICONIP 2003), Istanbul.

Hommel, B. (2001, January). *In the beginning was the act: A plea for an action-oriented approach to cognitive psychology.* Oration, University of Leiden, NL.

Hommel, B. (2001, May). *Stimulus-response translation and action planning in dual-task performance.* Colloquium 'Control of Cognitive Processes', Netherlands Royal Academy of Science, Amsterdam, NL.

J

Jovanovic, B., Aschersleben, G., & Prinz, W. (2001, August). *Do the effects of an action contribute to infants' perception of action goals?* Tutorials in Behavioural and Brain Sciences (TuBBS), Nijmegen, NL.

Jovanovic, B., Aschersleben, G., & Prinz, W. (2002, July). *Object-directed effects enhance infants' action interpretation.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kochel.

Jovanovic, B., Király, I., Aschersleben, G., Gergely, G., & Prinz, W. (2001, September). *Der Einfluss von Handlungseffekten auf die Wahrnehmung von Handlungszielen bei Säuglingen [The influence of action effects on the perception of action goals in infants].* 15. Tagung Entwicklungspsychologie, Potsdam.

Jovanovic, B., Király, I., Elsner, B., Aschersleben, G., Gergely, G., & Prinz, W. (2002, April). *Action effects enhance the perception of action goals.* 13th Biennial International Conference on Infant Studies (ICIS 2002), Toronto, Canada.

K

Keller, P. E. (2003, June). *Action planning in music performance.* Haskins Laboratories, New Haven, CT.

Keller, P. E., & Koch, I. (2003, March). *Stimulus-Reaktions- und Reaktions-Effekt Kompatibilität zwischen Tonhöhe und räumlicher Höhe [Stimulus-response and response-effect compatibility between pitch and height].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Keller, P. E., & Koch, I. (2003, June). *Action-effect compatibility in the production of tone sequences.* Biennial Meeting of the Society for Music Perception and Cognition (SMPC 2003), University of Nevada, Las Vegas, NV.

Kerzel, D. (2001, April). *Repräsentationales Momentum ist ein perzeptuelles Phänomen, keine Gedächtnisverzerrung [Representational Momentum is a perceptual phenomenon, not a memory distortion].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Kerzel, D. (2001, May). *Der Einfluss von Beobachteraktivität auf das visuelle Kurzzeitgedächtnis [The influence of observer activity on visual short-term memory].* Julius-Maximilians-Universität, Würzburg.

Kerzel, D. (2001, August). *Effects of stimulus material on the Fröhlich illusion.* 24th European Conference on Visual Perception (ECVP 2001), Kusadasi, Turkey.

Kerzel, D. (2002, January). *Die Welt ist nicht immer so, wie sie erscheint - Wahrnehmungstäuschungen und Handlungen [The world isn't always as it appears to be: Perceptual illusions and action].* Bucerius Law School, Hamburg.

Kerzel, D. (2002, February). *Fröhlich Illusion vs. Onset Repulsion: Effekte der psychophysischen Methode [Fröhlich Illusion vs. Onset Repulsion: Effects of psychophysical method].* 5. Tübinger Wahrnehmungskonferenz (TWK 2002), Tübingen.

Kerzel, D. (2002, March). *Aufmerksamkeit und 'Representational Momentum' bei implizierter Bewegung [Attention and 'Representational Momentum' with implied motion].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Kerzel, D. (2002, September). *The role of attention in the mislocalization of moving targets.* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Kerzel, D. (2003, February). *Asynchronous perception of motion and luminance change.* 6. Tübinger Wahrnehmungskonferenz (TWK 2003), Tübingen.

Kerzel, D. (2003, March). *Representational Momentum ist stärker bei motorischen Lokalisationsaufgaben und schwachem Bewegungseindruck [Representational Momentum is stronger with motor localization tasks and weak impression of motion].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Kerzel, D. (2003, September). *Mental Extrapolation of target position is strongest with weak motion signals and motor responses.* 26th European Conference on Visual Perception (ECVP 2003), Paris, France.

Kerzel, D. (2003, November). *'Representational Momentum': Dynamische Perzeption, nicht dynamische Repräsentation ['Representational Momentum': Dynamic perception, not dynamic representation].* Forschungskolloquium 'Theoretische und Experimentelle Kognitionspsychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

Kiefer, M., Schuch, S., Schenck, W., & Fiedler, K. (2001, March). *Emotional mood states modulate brain activation during episodic memory encoding.* 8th Annual Meeting of the Cognitive Neuroscience Society, New York, NY.

Kiefer, M., Schuch, S., Schenck, W., & Fiedler, K. (2002, March). *Stimmungszustände modulieren die Hirnaktivität beim episodischen Enkodieren [Emotional mood states modulate brain activation during episodic memory encoding].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Kim, D. (2002, May). *Design of whiskers with various sensor technologies.* AMOUSE project meeting, Max-Planck-Institut für Psychologische Forschung, München.

Kim, D. (2002, October). *A design of whisker prototype.* AMOUSE project meeting, Artificial Intelligence Laboratory, Zürich.

Kim, D. (2003, April). *An analysis of synchrony conditions for integrate-and-fire neurons.* 12th European Symposium on Artificial Neural Networks (ESANN' 2003), Bruges, Belgium.

Kim, D., & Lee, J. (2001, August). *Instance-based method to extract rules from neural networks.* International Conference on Artificial Neural Networks, Wien, Austria.

Kim, D., & Möller, R. (2003, October). *A design of multiple whiskers and frequency analysis for object detection.* AMOUSE project meeting, Hamburg.

Kiss, M., Wolber, M., & Wascher, E. (2002, March). *EEG-Korrelate der visuellen Suche in sequenziell aufgebauten Displays [Electrophysiological correlates of visual search in sequentially presented displays].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Kiss, M., Wolber, M., & Wascher, E. (2003, February). *EEG-Korrelate der Verarbeitung von alten Distraktoren in einer Variante der visuellen Suche [EEG correlates of old distractor processing in a variant of visual search].* 6. Tübinger Wahrnehmungskonferenz (TWK 2003), Tübingen.

Kiss, M., Wolber, M., & Wascher, E. (2003, March). *Visuelle Selektionsmechanismen bei zeitlicher Segmentierung des Suchdisplays [Mechanisms of visual selection in temporally segregated search displays].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Kiss, M., Wolber, M., & Wascher, E. (2003, June). *An electrophysiological investigation of the effects of visual marking.* Munich Visual Search Symposium, Holzhausen am Ammersee.

Klein, A., Hauf, P., & Aschersleben, G. (2003, July). *The role of action effects in infants' action understanding.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kloster Nimbschen, Grimma.

Knoblich, G. (2001, January). *Wahrnehmung eigener und fremder Handlungen [Perception of one's own and others' actions].* Institut für Psychologie, Universität Konstanz.

Knoblich, G. (2001, April). *Monitoring von Handlungseffekten [Monitoring of action effects].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Knoblich, G. (2001, June). *Action comprehension.* Annual Meeting of Theoretical & Experimental Neuropsychology (TENNET), Montreal, Canada.

Knoblich, G. (2001, September). *Koordination multipler Handlungen im Hinblick auf ein übergeordnetes Ziel [Coordination of multiple actions with regard to a higher-level goal].* 5. Fachtagung der Gesellschaft für Kognitionswissenschaft, Leipzig.

Knoblich, G. (2001, September). *Monitoring of action effects.* 2nd Lyon-Munich workshop, Max-Planck-Institut für Psychologische Forschung, München.

Knoblich, G. (2001, December). *Selbst-Zuschreibung von Wahrnehmungsereignissen [Attributing perceived events to oneself].* Psychiatrisches Institut, Universität Tübingen.

Knoblich, G. (2002, April). *Perceiving one's own and others' actions.* Center for Cognitive Neuroscience, Bangor, UK.

Knoblich, G. (2002, July). *Perceiving one's own actions.* Annual Meeting of the European Society for Philosophy and Psychology, Lyon, France.

Knoblich, G. (2002, September). *Wahrnehmung eigener und fremder Handlungen [Perception of one's own and others' actions].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Knoblich, G. (2002, October). *Action identity.* Symposium 'Self and Action', Ohlstadt.

Knoblich, G. (2002, November). *A cognitive approach to insight in problem solving.* Department of Psychology, Lancaster University, UK.

Knoblich, G. (2003, March). *Gedächtnis: Verlust und Konstruktion aus der Sicht der Neurowissenschaften und der Psychoanalyse [Memory: Loss and construction as viewed by the neurosciences and psychoanalysis].* Filmseminar, Evangelische Stadtakademie, München.

Knoblich, G. (2003, April). *Action identity.* Hanse-Wissenschaftskolleg, Delmenhorst.

Knoblich, G. (2003, April). *Action simulation: Evidence from self-recognition.* Institut für Psychologie, Universität Salzburg.

Knoblich, G. (2003, May). *Action identity.* Functional Imaging Laboratory, University College, London, UK.

Knoblich, G. (2003, July). *Simulation in action prediction.* Annual Meeting of the European Society for Philosophy and Psychology, Fondatione Roselli, Torino, Italy.

Knoblich, G. (2003, September). *Action identity: Evidence for action simulation?* EuroCogSci 03, Universität Osnabrück.

Knoblich, G. (2003, December). *Simulation in action recognition and action prediction.* Institute Jean Nicod, Paris, France.

Knoblich, G., Bach, P., Friederici, A. D., & Prinz, W. (2001, August). *Comprehension of action sequences: The case of paper, scissors, rock.* 23rd Annual Meeting of the Cognitive Science Society (CogSci 2001), Edinburgh, UK.

Knoblich, G., Bach, P., Gunter, T. C., Friederici, A. D., & Prinz, W. (2002, November). *Processing of meaning and structure in action comprehension.* 43rd Annual Meeting of the Psychonomic Society, Kansas City, MO.

Knoblich, G., Drost, U. C., & Goschke, T. (2001, September). *Coordination of multiple actions: How one hand wins against the other in paper, scissors, rock.* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

Knoblich, G., Leube, D., Erb, M., & Kircher, T. T. J. (2003, September). *Brain networks for identifying one's own actions.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Knoblich, G., & Öllinger, M. (2003, June). *A cognitive approach to insight in problem solving.* Nijmegen Institute of Cognition and Information, Nijmegen, NL.

Knoblich, G., Stottmeister, F., & Kircher, T. T. J. (2002, March). *Überwachung der Abbildung zwischen Bewegungen und ihren Effekten bei schizophrenen Patienten [Monitoring of the mapping between movements and their effects in schizophrenic patients].* 44. Tagung experimentell arbeitender Psychologen, Chemnitz.

Koch, I. (2001, April). *Das Zusammenspiel exogener und endogener 'Cues' beim Aufgabenwechsel [The interplay of exogenous and endogenous cues in task switching].* 43. Tagung experimentell arbeitender Psychologen (Teap), Regensburg.

Koch, I. (2001, May). *Automatic activation and decay of task sets: Evidence from incidental task-sequence learning.* Colloquium 'Control of Cognitive Processes', Netherlands Royal Academy of Science, Amsterdam, NL.

Koch, I. (2001, November). *Cognitive mechanisms of task preparation.* Illinois State University, Bloomington-Normal, IL.

Koch, I. (2002, February). *Code overlap and process interference in perception-action dual tasks.* Workshop 'Cognitive Neuroscience of Action', Kloster Irsee.

Koch, I. (2002, June). *Kognitive Mechanismen der Aufgabenvorbereitung [Cognitive mechanisms of task preparation].* Humboldt-Universität, Berlin.

Koch, I. (2002, June). *Kognitive Mechanismen der Aufgabenvorbereitung [Cognitive mechanisms of task preparation].* Institut für Arbeitsforschung, Dortmund.

Koch, I. (2002, July). *The role of internal and external cues in task switching.* International Symposium on Executive Functions: The interaction of endogenous and exogenous mechanisms for the control of action, Universität Konstanz.

Koch, I. (2002, September). *Die Rolle exogener und endogener Hinweisreize beim Aufgabenwechsel [The role of exogenous and endogenous cues in task switching].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Koch, I. (2003, March). *Der Einfluss visueller Wahrnehmungsaufgaben auf nachfolgende RT-Aufgaben: Zeitliche Überlappung und Kompatibilität der Aufgaben [The influence of visual perception tasks on succeeding RT tasks: Temporal overlap and compatibility of tasks].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Koch, I. (2003, October). *Cognitive control in task switching: Intentional and non-intentional factors.* Nijmegen Institute for Cognition and Information, Nijmegen, NL.

Koch, I. (2003, November). *Cognitive control in task switching: Intentional and non-intentional factors.* Beer Sheva, Israel.

Koch, I., & Allport, A. (2002, March). *Dissoziierbare Bahnungseffekte beim Aufgabenwechsel [Dissociable priming effects in task switching].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Contributions to Congresses and Invited Lectures

Koch, I., Gade, M., & Philipp, A. M. (2003, September). *Inhibition of response mode in task switching.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Koch, I., & Prinz, W. (2001, September). *Intentional coding can reverse spatial cross-task compatibility.* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

Koch, I., & Prinz, W. (2001, November). *Process interference and code oberlap in dual-task performance.* 42nd Annual Meeting of the Psychonomic Society, Orlando, FL.

Koch, I., Ruge, H., Braß, M., Rubin, O., Meiran, N., & Prinz, W. (2003, November). *Equivalence of cognitive processes in brain-imaging and behavioral studies: Evidence from task switching.* 44th Annual Meeting of the Psychonomic Society, Vancouver, Canada.

Koch, I., & Schuch, S. (2003, March). *Interferenz in Doppelaufgaben: Repräsentationen und Prozesse [Interference in dual tasks: Representations and processes].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

L

Laboissière, R. (2002, June). *Computational approaches to motor control: Testing the equilibrium point hypothesis.* Forschungskolloquium 'Allgemeine und Experimentelle Psychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

Laboissière, R., Shiller, D. M., & Ostry, D. J. (2001, October). *Techniques for estimating jaw mechanical properties during speech movements.* 3rd Conference on Sensorimotor Controls in Men and Machines, Université de la Méditerranée, Marseille, France.

Lohmann, P., Müsseler, J., & Esser, K. H. (2001, June). *Vocal effects of delayed auditory feedback in the lesser spear-nosed bat Phyllostomus discolor.* 6th International Congress of Neuroethology, Bonn.

M

Maasen, S. (2002, July). *Bewusstseinsveränderungen. Die neurokognitive Herausforderung des Diskurses zum Bewusstsein [Changes in consciousness. Neurocognitive challenges to the discourse on consciousness].* Tagung 'Unsichtbare Feinde - Politische Metaphern (in) der Bakteriologie und Immunologie', Universität Zürich.

Maasen, S. (2003, February). *From 'lessons on will' to 'self-management': On the social construction of the will.* Munich Philosophical Lecture Series on the Nature and Culture of Volition, Max-Planck-Institut für Psychologische Forschung, München.

Mayer, G., & Rieger, M. (2002, December). *Aufmerksamkeitsdefizite und Depression bei Narkolepsie [Attention deficits and depression in narcolepsy].* Jahreskongress der Deutschen Gesellschaft für Psychiatrie, Psychotherapie und Nervenheilkunde (DGPPN), Berlin.

Mechsner, F. (2001, January). *Bimanuelle Koordination [Bimanual coordination].* Abteilung für Psychiatrie, Universität Bern, Switzerland.

Mechsner, F. (2001, January). *Tausendfüßlers Dilemma: Über die unterschiedliche funktionale Rolle von bewussten und unbewussten Prozessen bei der Koordination von Bewegungen [Millepede's dilemma: On the differing functional role of conscious and subconscious processes in movement coordination].* Symposium der dvs-Sektion Sportmotorik 'Bewusstsein, Bewegung, Lernen', Gießen.

Mechsner, F. (2001, February). *Fast and frugal strategies in voluntary movements.* Max-Planck-Institut für Bildungsforschung, Berlin.

Mechsner, F. (2001, February). *Hände und Werkzeuge [Hands and tools].* Universität Braunschweig.

Mechsner, F. (2001, March). *Bewegte Hände: Das 'Äußere Gehirn' in Aktion [Hands in motion: The 'Outer Brain' in action].* Zentrum für Allgemeine Wissenschaftliche Weiterbildung (ZaWiW), Universität Ulm.

Mechsner, F. (2001, May). *Aufmerksamkeit und Bewegungskoordination [Attention and movement coordination].* 33. Fachtagung Sportpsychologie, Magglingen, Switzerland.

Mechsner, F. (2001, May). *Eine Theorie des Kleinhirns [A theory of the cerebellum].* Deutsches Zentrum für Luft- und Raumfahrt, Oberpfaffenhofen.

Mechsner, F. (2002, March). *Wahrnehmung und Erzeugung von paarigen Kreisbewegungen [Perception and production of paired circling movements].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Mechsner, F. (2002, December). *Bewegungsplanung hat nichts mit Muskeln zu tun - Evidenz aus Experimenten zur bimanuellen Koordination [Muscles don't matter in movement planning - Evidence from experiments on bimanual coordination].* Symposium 'Kognition und Bewegungssteuerung', Deutsche Sporthochschule, Köln.

Mechsner, F. (2002, December). *Hände und Werkzeuge [Hands and tools].* Forschungskolloquium 'Allgemeine und Experimentelle Psychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

Mechsner, F. (2003, March). *Strategien bei der Planung und Ausführung menschlicher Bewegungen [Strategies in human movement planning and performance].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Mechsner, F. (2003, November). *Bimanuale Koordination [Bimanual coordination].* Forschungskolloquium 'Theoretische und Experimentelle Kognitionspsychologie', Ludwig-Maximilians-Universität, München.

Mechsner, F., Kerzel, D., & Prinz, W. (2001, March). *Coupling of perception and action in bimanual coordination.* 4. Tübinger Wahrnehmungskonferenz (TWK 2001), Tübingen.

Mechsner, F., & Prinz, W. (2001, September). *Perceptual coupling in limb and tool movements.* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

Mechsner, F., & Prinz, W. (2001, November). *Pattern perception and production in paired circling movements.* 42nd Annual Meeting of the Psychonomic Society, Orlando, FL.

Möller, R. (2001, November). *Biorobotik: Biologie in der Robotik und Robotik in der Biologie [Biorobotics: Applying biology in robotics and robotics in biology].* St. Gallische Naturwissenschaftliche Gesellschaft, St. Gallen, Switzerland.

Möller, R. (2001, December). *Vorwärtsmodelle in der räumlichen Wahrnehmung [Forward models in spatial perception].* Abteilung Kognitionspsychologie, Universität Würzburg.

Möller, R. (2002, June). *Forward models in spatial perception.* 8th German-American Frontiers of Science Symposium, A.-v.-Humboldt-Stiftung / National Academy of Sciences, Irvine, CA.

Möller, R. (2002, July). *Biorobotik: Biologie in der Robotik und Robotik in der Biologie [Biorobotics: Applying biology in robotics and robotics in biology].* Universität Kaiserslautern.

Möller, R. (2002, July). *Towards a sensorimotor theory of visual perception.* Zentrum für interdisziplinäre Forschung (ZiF), Universität Bielefeld.

Möller, R. (2003, February). *Forward models in spatial cognition.* 6. Tübinger Wahrnehmungskonferenz (TWK 2003), Tübingen.

Moore, C. M., Lleras, A., & Grosjean, M. (2001, May). *Perception and action under conditions of inattention.* 1st Annual Meeting of the Vision Sciences Society, Sarasota, FL.

Müller, K., Aschersleben, G., & Prinz, W. (2002, September). *Zentrale Korrelate inter- und intrasensorischer Integration [Neural correlates of inter- and intrasensory integration].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Müller, K., Aschersleben, G., Schmitz, F., Schnitzler, A., & Prinz, W. (2003, March). *Neuromagnetic correlates of inter- and intrasensory synchronization.* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Müsseler, J. (2001, April). *Visuelle Lokalisation bei Reizbewegung [Visual localization of moving stimuli].* Symposium der Fachgruppe Allgemeine Psychologie: Modellierung und Psychophysik kognitiver Prozesse, Universität Regensburg.

Müsseler, J. (2001, June). *Visuelle Lokalisation bei Reizbewegung [Visual localization of moving stimuli].* Arbeitstreffen DFG-Schwerpunktptogramm 1001 'Sensumotorische Intergration': Metacontrast, Sensorimotor Integration, and Attentional Selection, Universität Bielefeld.

Müsseler, J. (2001, July). *Reizbewegung und visuelles Lokalisieren: Der Fröhlich-Effekt, der Flash-Lag Effekt und das repräsentationale Momentum [Moving stimuli and localization: The Fröhlich effect, the flash-lag effect and representational momentum].* Graduiertenkolleg 'Sensorische Interaktion in biologischen und technischen Systemen', Ludwig-Maximilians-Universität München.

Müsseler, J. (2002, January). *Raumwahrnehmung und die Verlagerung von Aufmerksamkeit im Gesichtsfeld [Space perception and attentional shifts in the visual field].* Universität Mainz.

Müsseler, J. (2002, April). *Localization of moving stimuli.* Department of Experimental Psychology, Ghent University, Belgium.

Müsseler, J. (2002, May). *Action-evoked modulations in visual encoding: Can actions affect perceptual processing?* Research Council, Ghent University, Belgium.

Müsseler, J. (2002, September). *Localization of moving and stationary stimuli.* Symposium 'Visual Space Perception and Action', Ohlstadt.

Müsseler, J. (2002, November). *Hemisphärenunterschiede bei visuellen Enkodierungsprozessen? [Hemispheric differences in visual encoding?].* 35. Herbsttagung Experimentelle Kognitionspsychologie (HexKoP), Oerlinghausen.

Müsseler, J. (2003, January). *Action-evoked modulations in visual encoding: Visual space perception and action.* Research Council, Ghent University.

Müsseler, J. (2003, February). *Blickbewegungen und die wahrgenommene Objektposition im Raum [Saccadic eye movements and the perceived position of objects in space].* Universität Jena.

Müsseler, J. (2003, July). *Sensorische und motorische Prozesse etablieren den wahrgenommenen Raum: Evidenz durch eine relative Wahrnehmungstäuschung [Sensorimotor processes establish the perceptual space: Evidence from a relative perceptual illusion].* Universität Erlangen-Nürnberg.

Müsseler, J. (2003, July). *Wirken sich Handlungen auf unsere Wahrnehmung aus? Handlungsbedingte Modulationen visueller Enkodierungsprozesse [Do actions affect visual perception? Action-evoked modulations of visual encoding].* Universität Bonn.

Müsseler, J. (2003, September). *Saccades and localization judgments with briefly presented stimuli.* 26th European Conference on Visual Perception (ECVP 2003), Paris, France.

Müsseler, J. (2003, September). *Spatial conflicts between response planning and visual encoding in dual tasks.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Müsseler, J., & Kerzel, D. (2003, November). *Mislocalizations of the onset position of a moving target: Reconciling the Fröhlich and onset-repulsion effects.* 44th Annual Meeting of the Psychonomic Society, Vancouver, Canada.

Müsseler, J., & Stork, S. (2002, August). *Localization of flashed stimuli presented in the retinal periphery.* Symposium 'Visual Localization in Space and Time', University of Sussex, UK.

Müsseler, J., Stork, S., & Kerzel, D. (2001, April). *Wahrgenommene Fehllokalisationen in Bewegungsrichtung [Perceived mislocalization in the direction of motion].* 43. Tagung experimentell arbeitender Psychologen (Teap), Regensburg.

Müsseler, J., Stork, S., & Kerzel, D. (2001, August). *Comparing mislocalizations with moving stimuli: The Fröhlich effect, the flash-lag effect and representational momentum.* 24th European Conference on Visual Perception (ECVP 2001), Kusadasi, Turkey.

Müsseler, J., Stork, S., & Neggers, S. F. W. (2001, September). *Eye movements and the perceived vanishing point of a moving stimulus.* 5. Fachtagung der Gesellschaft für Kognitionswissenschaft, Leipzig.

Müsseler, J., & Wühr, P. (2001, March). *Motorisch hervorgerufene Modulationen visueller Enkodierungsprozesse [Motor-evoked modulations in visual encoding].* 4. Tübinger Wahrnehmungskonferenz (TWK 2001), Tübingen.

Müsseler, J., & Wühr, P. (2003, February). *Gibt es bei Mehrfachtätigkeit Hemisphärenunterschiede in der visuellen Enkodierung? [Are there hemispheric differences in visual encoding when performing dual tasks?].* 6. Tübinger Wahrnehmungskonferenz (TWK 2003), Tübingen.

Müsseler, J., & Wühr, P. (2003, March). *Wahrnehmungsbeeinträchtigungen in Doppeltätigkeitsaufgaben: Gibt es Hemisphärenunterschiede? [Perceptual impairment during dual tasks: Is it based on hemispheric differences?].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

N

Nakamura, A., Maeß, B., Gunter, T. C., Knösche, T. R., Bach, P., & Friederici, A. D. (2002, June). *Recognition of hand postures in humans - A brain electromagnetic study.* 8th International Conference on Functional Mapping of the Human Brain, Sendai, Japan.

Nakamura, A., Maeß, B., Gunter, T. C., Knösche, T. R., Bach, P., Kato, T., et al. (2002, August). *Visual event-related magnetic fields to hand postures.* 13th International Conference on Biomagnetism (BIOMAG 2002), Jena.

Nunner-Winkler, G. (2001, March). *Moral und Beziehungsverständnis [Morality and the understanding of social relations].* Workshop 'Soziale Bindung und Differenz: Innere Widersprüche des Zusammenlebens', Essen.

Nunner-Winkler, G. (2001, May). *Familie und Erziehung - Anforderungen und Erschwernisse [Family and education: Demands and impediments].* Fachkongress 'Mut zur Erziehung - Zumutung Erziehung', Weimar.

Nunner-Winkler, G. (2001, May). *Moralbildung (Erwerb von moralischen Kompetenzen) [Moral development (Acquisition of moral competences)].* Symposium 'Das Gesetz bin ich - keine Regel ohne Ausnahme', Propstei Wislikofen, Switzerland.

Nunner-Winkler, G. (2001, June). *Gut und Böse in der Sozialisation von Kindern und Jugendlichen [Good and evil in the socialisation of children and adolescents].* 17. Bayreuther Historisches Kolloquium, Bayreuth.

Nunner-Winkler, G. (2001, July). *Moralisches Urteil - moralisches Handeln [Moral judgment and moral action].* Forschungskolloquium, Philosophische Fakultät, Lehrstuhl für Pädagogik, Universität Regensburg.

Nunner-Winkler, G. (2001, July). *Zivilcourage als Persönlichkeitsdisposition - Bedingungen der individuellen Entwicklungen [Courage of one's convictions as a personality disposition - conditions of individual development].* 6. Dietrich-Bonhoeffer-Vorlesung, Ludwig-Maximilians-Universität, München.

Contributions to Congresses and Invited Lectures

Nunner-Winkler, G. (2001, October). *Sociohistoric changes and the structure of moral motivation.* Symposium in honor of Augusto Blasi, Association for Moral Education, Vancouver, Canada.

Nunner-Winkler, G. (2001, November). *Moralische Geschlechterdifferenz - ein Generationenvergleich [Gender differences in moral understanding - a cohort comparison].* Seminar 'Moral und die Konstruktion von Geschlecht - empirische Zugangsweisen', Universität Göttingen.

Nunner-Winkler, G. (2001, November). *Moralisches Urteil - moralisches Handeln [Moral judgment and moral action].* Seminar 'Zur Entwicklung individueller Wertorientierungen', Bundeszentrale für politische Bildung, Brühl/Bonn.

Nunner-Winkler, G. (2002, January). *Die Bedeutung der Interaktion unter Gleichaltrigen für die moralische Entwicklung [The role of peer interaction in moral development].* Wissenschaftliches Symposium zur Verabschiedung von Prof. L. Krappmann, Max-Planck-Institut für Bildungsforschung, Berlin.

Nunner-Winkler, G. (2002, January). *Identität und Moral [Identity and morality].* Psychologisches Kolloquium, Universität Göttingen.

Nunner-Winkler, G. (2002, February). *Moralentwicklung im Verlauf des Lebens [Moral development during the life course].* Symposium zum Gedenken an Franz E. Weinert 'Entwicklung, Lehren und Lernen', München.

Nunner-Winkler, G. (2002, May). *Identität als Wertbindung [Identity as a commitment to values].* Psychologisches Kolloquium, Universität Hildesheim.

Nunner-Winkler, G. (2002, June). *Wandel im alltagsweltlichen Moralverständnis [Changes in everyday moral understanding].* 'Corti-Lectures' - Gegenwart und Zukunft der Moral. Historisch-rekonstruktive, sozialphilosophische und sozialwissenschaftliche Reflexionen, Universität Zürich, Switzerland.

Nunner-Winkler, G. (2002, June). *Wie lernen Kinder Moral? [How children learn morality].* Seminarreihe 'Wertevermittlung in der Gesellschaft - Sinnsuche und Konfliktlösungen im 21. Jahrhundert. Neue Werte für neue Menschen in einem vereinten Europa?', Friedrich-Ebert-Stiftung - Internationales Friedenskolleg e.V, Berlin.

Nunner-Winkler, G. (2002, July). *Abortion: Moral gender perspectives.* Conference 'Legal Decisions About Life and Death - And what Lawyers Can Learn from Other Experts', Deutsch-Israelische Juristenvereinigung, Wiesbaden.

Nunner-Winkler, G. (2002, September). *Moralischer Wandel - Moralisches Lernen [Changes in moral understanding and moral learning].* Podiumsdiskussion (Panel): McKinsey bildet - Eine Initiative zum Thema 'Bildung in Deutschland', Berlin.

Nunner-Winkler, G. (2002, September). *The development of moral motivation.* European Research Conference 'European Societies or European Society?', European Science Foundation, Seefeld, Austria.

Nunner-Winkler, G. (2002, October). *Entwicklung des Moralverständnisses bei Kindern und Jugendlichen [The development of moral understanding in children and adolescents].* Landesfachtagung 'Entwicklungen begleiten - Halt geben', Evangelischer Erziehungsverband in Bayern, Schweinfurth.

Nunner-Winkler, G. (2002, November). *Empirische Einschätzung zur Sensibilität von Kindern und Jugendlichen für das Gerechtigkeits- und Anerkennungsproblem [Empirical data concerning children's and adolescents' understanding of justice and recognition].* Kongress 'Gerechtigkeit in einer globalisierten Welt - Anfragen an Theologie und Religionsunterricht', Katholisch-Theologische Fakultät, Westfälische Wilhelms-Universität, Münster.

Nunner-Winkler, G. (2002, November). *Moralvorstellungen im Wandel [Changes in moral understanding].* Forschungskolloquium, Soziologisches Institut, Universität Bern, Switzerland.

Nunner-Winkler, G. (2003, March). *Emotions and moral understanding.* Exploratory Workshop 'Emotion, Consciousness and Self-Consciousness', European Science Foundation, St. John's College, Cambridge, UK.

Nunner-Winkler, G. (2003, March). *Werte und Moral als integrative Grundlagen moderner Gesellschaften [Values and morality - integrative bases of modern societies].* Workshop 'Desintegrationsprozesse', Forschungsverbund 'Stärkung von Integrationspotentialen einer modernen Gesellschaft', Humboldt-Universität Berlin.

Nunner-Winkler, G. (2003, April). *Wertbindungen und Identität [Commitment to values and identity].* Kolloquium 'Welche Identität braucht der Mensch? Heimat - Sprache - Natur', Guardini-Stiftung e.V, Wittenberg.

Nunner-Winkler, G. (2003, April). *Zur Entwicklung moralischer Motivation von Kindern und Jugendlichen [The development of moral understanding in children and adolescents].* 2. Würzburger Familiensymposium, Diakonisches Werk Würzburg - Evangelische Kinder- und Jugendhilfe, Würzburg.

Nunner-Winkler, G. (2003, May). *Moralvorstellungen im Wandel [Changes in moral understanding].* Forschungskolloquium, Institut für Politikwissenschaften, Universität Leipzig.

Nunner-Winkler, G. (2003, June). *Der strategische Einsatz von Moral [Strategic uses of morality].* Symposium 'Skandal und Politische Bildung', Institut für Allgemeine Erziehungswissenschaften, Westfälische Wilhelms-Universität, Münster.

Nunner-Winkler, G. (2003, June). *Gefühle und Moralentwicklung. Positionen und Methoden empirischer Forschung [Emotions in moral development - claims and procedures in empirical research].* Lektüretagung 'Die Macht der Gefühle und die Möglichkeit der Freiheit. Spinozas Genealogie des verkehrten Lebens', Spinoza Gesellschaft, Kloster Benediktbeuern.

Nunner-Winkler, G. (2003, September). *Die Erblichkeit von Einstellungen - Ein Artefakt verhaltensgenetischer Überinterpretation [The heritability of attitudes - an artefact of overinterpretations in behavioural genetics].* 16. Tagung Entwicklungspsychologie, Mainz.

Nunner-Winkler, G. (2003, October). *Formen von Gewalt [Forms of violence].* Round table 'Jugendgewalt - ohne Grund?', Institut für Sozialforschung, Johann Wolfgang Goethe-Universität, Frankfurt/Main.

Nunner-Winkler, G. (2003, October). *Frauen im Recht: Auswirkungen auf Strafzumessungen? [Women in law: Effects on sentencing policy?].* Tagung 'Frauen in der Justiz', Deutscher Richterbund - Landesverband Hessen, Hochheim.

Nunner-Winkler, G. (2003, October). *Identität und Wertbindung [Identity and commitment to values].* Eröffnung der Pädagogischen Fachhochschule Aargau, Switzerland.

Nunner-Winkler, G. (2003, November). *Alltagsweltliches Moralverständnis und philosophische Ethik. Ein Beitrag aus der empirischen Moralforschung [Everyday moral understanding in philosophical ethics. A contribution from empirical research on morality].* Symposium 'Formen der Kommunikation und die Grundlagen der Ethik (Habermas und Tugendhat)', Martin-Luther-Universität, Halle-Wittenberg.

O

Öllinger, M., & Knoblich, G. (2002, September). *Einstellungseffekte und Vorwissen bei der Lösung von Einsichtsproblemen [The influence of set and prior knowledge on the solution of insight].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Öllinger, M., & Knoblich, G. (2003, September). *Insight creates set for familiar problems.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Öllinger, M., & Knoblich, G. (2003, November). *Set and insight.* 44th Annual Meeting of the Psychonomic Society, Vancouver, Canada.

Öllinger, M., Knoblich, G., & Koch, I. (2001, April). *Sequenzlernen bei Papier, Schere, Stein [Sequence learning in paper, scissors, rock].* 43. Tagung experimentell arbeitender Psychologen (TeaP), Regensburg.

Öllinger, M., Knoblich, G., & Koch, I. (2002, March). *Sequenzlernen bei koordinierten Handlungen [Sequence learning in coordinated actions].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

P

Philipp, A. M., & Koch, I. (2002, September). *The effect of response selection on control processes.* EuroConference and EBBS workshop on Cognitive and Neural Mechanisms of Visuomotor Control, La Londe, France.

Philipp, A. M., & Koch, I. (2002, October). *Die Rolle der Antwortauswahl bei der Rekonfiguration von Aufgaben-„Sets" [The role of response selection on the reconfiguration of task sets].* 17. Jahrestagung der Gesellschaft für Neuropsychologie, Ruhr-Universität Bochum.

Philipp, A. M., & Koch, I. (2003, March). *Reaktionsauswahl und Hemmung beim Aufgabenwechsel [Response selection and inhibition in task switching].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Philipp, A. M., & Koch, I. (2003, July). *Response selection account of task switching.* Arbeitstreffen DFG-Schwerpunktptogramm 1107 'Executive Functions', Fulda.

Philipp, A. M., & Koch, I. (2003, September). *Effects of response selection on the task-repetition benefit in task switching.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Philipp, A. M., Schuch, S., & Koch, I. (2002, September). *Die Rolle der Antwortauswahl im Aufgabenwechselparadigma [The role of response selection in the task switching paradigm].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Pollok, B., Dirks, M., Gross, J., Timmermann, L., & Schnitzler, A. (2003, March). *Das zerebrale oszillatorische Netzwerk eines imitierten Ruhetremors - Eine MEG-Studie [The cerebral oscillatory network of an imitated resting tremor - an MEG study].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Pollok, B., Moll, M., Schmitz, F., Müller, K., & Schnitzler, A. (2002, August). *Rapid mapping of finger representations in human primary somatosensory cortex applying neuromagnetic steady-state responses.* 13th International Conference on Biomagnetism (BIOMAG 2002), Jena.

Pollok, B., Müller, K., & Aschersleben, G. (2001, August). *Neuromagnetic correlates of bimanual synchronization.* Tutorials in Behavioural and Brain Sciences (TuBBS), Nijmegen, NL.

Pollok, B., Müller, K., & Prinz, W. (2002, March). *Neuronale Grundlagen der bimanualen Koordination - Eine MEG-Studie [Neural foundations of bimanual coordination - An MEG study].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Pösse, B., & Hommel, B. (2001, April). *Interaktionen zwischen Reiz- und Reaktionsbindung und Aufgabenwechsel [Interactions between stimulus and response binding and task switch].* 43. Tagung experimentell arbeitender Psychologen (Teap), Regensburg.

Prinz, W. (2001, January). *Das unmittelbare und das mittelbare Selbst [The immediate and the mediate self].* Ludwig-Maximilians-Universität, München.

Prinz, W. (2001, January). *Nachahmung: Experimentelle Untersuchungen [Imitation: Experimental analyses].* Freie Universität, Berlin.

Prinz, W. (2001, January). *Nachahmung: Experimentelle Untersuchungen [Imitation: Experimental studies].* Universität Jena.

Prinz, W. (2001, February). *Neue Beobachtungen über bimanuale Kopplung [New observations on bimanual coupling].* Universität Kiel.

Prinz, W. (2001, June). *Willensfreiheit - Illusion oder Wirklichkeit? [Free will: Illusion or reality?].* Evangelische Akademie, Mülheim/Ruhr.

Prinz, W. (2001, November). *Willensfreiheit [Free will].* Hanse-Wissenschaftskolleg, Delmenhorst.

Prinz, W. (2001, December). *Bimanuale Koordination [Bimanual coordination].* Psychologisches Institut, Universität Zürich, Switzerland.

Prinz, W. (2002, February). *Understanding the brain's proper functions: The case of ideomotor action.* Intersektionelles Forum der Max-Planck-Gesellschaft, Harnack-Haus, Berlin.

Prinz, W. (2002, May). *An ideomotor approach to imitation.* International University (IUB), Bremen.

Prinz, W. (2002, May). *An ideomotor approach to imitation.* Conference 'Perspectives on imitation: From cognitive neuroscience to social science', Abbaye de Royaumont, France.

Prinz, W. (2002, September). *Ideomotorische Handlungstheorie [A theory of ideomotor action].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Prinz, W. (2002, September). *Intention in action.* London Meeting of the Experimental Psychology Society, London, UK.

Prinz, W. (2002, September). *Was braucht man, um Handlungen zu erklären? [What is required to explain actions?].* Kulturwissenschaftliches Institut (KWI), Essen.

Prinz, W. (2003, January). *Handlungen erklären [Explaining action].* Symposium 'Willensfreiheit als Problem der Psychologie', Psychologisches Institut, Universität Hildesheim.

Prinz, W. (2003, June). *Experiments on cognition and action.* Zentrum für interdisziplinäre Forschung (ZiF), Universität Bielefeld.

Prinz, W. (2003, June). *Kognition und Handlung [Cognition and action].* Leopoldina, Halle.

Prinz, W. (2003, September). *Kritik des freien Willens: Psychologische Bemerkungen [A critique of free will: Psychological remarks].* Gesellschaft für Analytische Philosophie, Universität Bielefeld.

Prinz, W. (2003, September). *Re-enactment: What it does and doesn't earn you.* EuroCogSci 03, Osnabrück.

Prinz, W. (2003, October). *Kritik des freien Willens. Psychologische Bemerkungen zu einer sozialen Institution [A critique of free will: Psychological remarks on a social institution].* Berlin-Brandenburgische Akademie der Wissenschaften, Berlin.

Prinz, W. (2003, November). *Interactions between action and perception.* Center for Mind, Brain & Learning, University of Washington, Seattle, WA.

Prinz, W. (2003, November). *Notions of simulation.* Workshop 'Variaties of Action Simulation', Max-Planck-Institut für Psychologische Forschung, München.

Prior, P., Hauf, P., & Sarris, V. (2003, March). *Verarbeitungsprinzipien der linken und rechten Hemisphäre - Befunde aus der Bezugssystemforschung [Principles of processing in left and right hemisphere: Findings from frame-of-reference research].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

R

Rapinett, G. (2003, November). *Timing and prediction in an action simulation paradigm.* Workshop 'Variaties of Action Simulation', Max-Planck-Institut für Psychologische Forschung, München.

Rieger, M. (2001, November). *Aufmerksamkeitsdefizite bei Patienten mit Narkolepsie [Attention deficits in patients with narcolepsy].* Technische Universität, Chemnitz.

Rieger, M. (2002, September). *Automatische Aktivierung von Reaktionen bei Experten im Tippen [Automatic activation of reactions in typing experts].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Rieger, M. (2002, November). *Die Aktivierung von Reaktionen bei Experten im Schreibmaschineschreiben [Activation of reaction in typing experts].* Workshop 'Ideomotorische Handlungskontrolle', Bamberg.

Contributions to Congresses and Invited Lectures

Rieger, M. (2003, July). *A role for the right frontal lobes in the inhibition of ongoing responses?* Joint meeting of the International Neuropsychological Society (INS) and the Gesellschaft für Neuropsychologie (GNP), Berlin.

Rieger, M. (2003, December). *Handlungsziele und Handlungseffekte [Action goals: Targets and effects].* Rundgespräch 'AntizipativeVerhaltenssteuerung', Hanse-Wissenschaftskolleg, Delmenhorst.

Rieger, M., & Elsner, B. (2002, November). *Automatic activation of movements in typewriting experts.* 43rd Annual Meeting of the Psychonomic Society, Kansas City, MO.

Rieger, M., Kandzia, W., & Prinz, W. (2002, March). *Die Aktivierung von Handlungen durch ihre Effekte beim Tippen [Activation of actions by action effects in typing].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Rieger, M., Knoblich, G., & Prinz, W. (2003, March). *Die Rolle visueller Bewegungseffekte - Veränderung von Zielposition und Gain in einem kontinuierlichen Adaptationsparadigma [The role of visual movement effects - changes of target position and gain in a continuous adaptation paradigm].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Rieger, M., Knoblich, G., & Prinz, W. (2003, September). *Compensation of and adaptation to changes during continuous movements.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Rieger, M., Knoblich, G., & Prinz, W. (2003, November). *Compensation for and adaptation to changes in the environment.* 44th Annual Meeting of the Psychonomic Society, Vancouver, Canada.

Ritzl, A., Wohlschläger, A., Vogeley, K., Schilbach, L., Zilles, K., & Fink, G. R. (2003, September). *Motor influence on apparent motion perception: An fMRI-study.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Ruge, H., Braß, M., Koch, I., Meiran, N., & von Cramon, D. Y. (2002, March). *Vorbereiten vs. Implementieren: Eine fMRT Studie zur aufgabenwechselbezogenen kognitiven Kontrolle [Preparation vs. implementation: A fMRI studie on task-switch related cognitive control].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Ruge, H., Braß, M., Koch, I., & von Cramon, D. Y. (2003, March). *Re-Interpretation von Verhaltensdaten im Aufgabenwechselparadigma durch Berücksichtigung von fMRT Befunden [Reinterpretation of behavioral data in the task switching paradigm based on consideration of fMRI findings].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

S

Sarris, V., Hauf, P., & Arlt, M. (2001, October). *Psychophysics of color and size discrimination: New data and preliminary conclusions.* 17th Annual Meeting of the International Society for Psychophyiscs (Fechner Day), Leipzig.

Schenck, W. (2003, March). *EVA - ein konnektionistisches Modell für menschliches Planungsverhalten [EVA - a connectionist model for human planning behavior].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Schenck, W. (2003, April). *Konnektionismus und situiertes Handeln als Gegenentwürfe zum Symbolverarbeitungsansatz [Connectionism and situated action as counterdraft to the symbol-processing approach].* Gesellschaft für Soziologie, Graz, Austria.

Schenck, W. (2003, August). *Staged learning of fixation movements with a robot camera head.* Machine Learning Summer School 2003, Max-Planck-Institut für biologische Kybernetik, Tübingen.

Schenck, W., Hoffmann, H., & Möller, R. (2003, September). *Learning internal models for eye-hand coordination in reaching and grasping.* EuroCogSci 03, Universität Osnabrück.

Schenck, W., & Möller, R. (2003, August). *Staged learning of saccadic eye movements.* 8th Neural Computation and Psychology Workshop, University of Kent, Canterbury, UK.

Schuch, S., & Koch, I. (2001, August). *Response selection causes inhibition of task sets in task shifting.* Tutorials in Behavioural and Brain Sciences (TuBBS), Nijmegen, NL.

Schuch, S., & Koch, I. (2001, September). *Response selection causes inhibition of task set in task switching.* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

Schuch, S., & Koch, I. (2002, March). *Reaktionsumkodierung in Doppelaufgaben [Response recoding in dual tasks].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Schuch, S., & Koch, I. (2002, July). *Costs of response repetition and response compatibility in dual tasks.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kochel.

Schuch, S., & Koch, I. (2002, September). *Costs of response repetition in dual tasks.* EuroConference and EBBS workshop on Cognitive and Neural Mechanisms of Visuomotor Control, La Londe, France.

Schuch, S., & Koch, I. (2002, September). *Reaktionswiederholungskosten in Doppelaufgaben [Costs of response repetition in dual tasks].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Schuch, S., & Koch, I. (2002, November). *Reaktionsauswahl und Aufgabenkontext [Response selection and task context].* Institut für Psychologie, Universität Konstanz.

Schuch, S., & Koch, I. (2002, November). *Response selection in changing task contexts.* Department of Psychology, University of Oregon, Eugene, OR.

Schuch, S., & Koch, I. (2002, November). *The role of response selection for inhibition of task sets in task shifting.* 43rd Annual Meeting of the Psychonomic Society, Kansas City, MO.

Schuch, S., & Koch, I. (2003, June). *Antwortauswahl bei Mehrfachaufgaben und Aufgabenwechsel [Response selection in multitasks and task switching].* Medizinische Fakultät, Universität Ulm.

Schuch, S., & Koch, I. (2003, July). *Response grouping in dual tasks.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kloster Nimbschen, Grimma.

Schuch, S., & Koch, I. (2003, September). *Response grouping in dual tasks.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Schuch, S., Koch, I., & Kunde, W. (2003, November). *Response grouping in dual tasks.* 44th Annual Meeting of the Psychonomic Society, Vancouver, Canada.

Sebanz, N., & Green, D. W. (2001, September). *The mental representation of gender in German monolingual and German-Italian bilingual speakers.* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

Sebanz, N., Knoblich, G., & Prinz, W. (2002, March). *Gemeinsam oder allein? Effekte der Aufgabenteilung in der Handlungsplanung [Together or alone? Effects of task sharing on action planning].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Sebanz, N., Knoblich, G., & Prinz, W. (2002, September). *Gemeinsam oder einsam? Effekte des sozialen Kontexts auf die Handlungsplanung [Together or alone? Effects of social context on action planning].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Sebanz, N., Knoblich, G., & Prinz, W. (2002, September). *How two share space: Effects of social context on the visual processing of spatial stimuli.* EuroConference and EBBS workshop on Cognitive and Neural Mechanisms of Visuomotor Control, La Londe, Fance.

Sebanz, N., Knoblich, G., & Prinz, W. (2002, November). *How two share space.* 43rd Annual Meeting of the Psychonomic Society, Kansas City, MO.

Sebanz, N., Knoblich, G., & Prinz, W. (2003, March). *You are always on my mind - Representing others´ actions and intentions.* Cognition and Brain Sciences Unit, Cambridge, UK.

Sebanz, N., Knoblich, G., & Prinz, W. (2003, August). *Social Simon: Investigating the representation of others´ actions.* Massachusetts Institute of Technology (MIT), Boston, MA.

Sebanz, N., Knoblich, G., & Prinz, W. (2003, August). *Your task is my task: Shared task representations in dyadic interactions.* 25th Annual Meeting of the Cognitive Science Society (CogSci 2003), Boston, MA.

Sebanz, N., Knoblich, G., Prinz, W., & Wascher, E. (2003, September). *Modulations of the P3 through social context.* 5th Congress of the Federation of European Psychophysiology Societies, Bordeaux, France.

Sebanz, N., Knoblich, G., Wascher, E., & Prinz, W. (2003, March). *Twin Peaks: ERP-Korrelate des gemeinsamen Handelns [Twin peaks: ERP correlates of joint action].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Sebanz, N., Knoblich, G., Wascher, E., & Prinz, W. (2003, September). *Representing others´ actions: An ERP study of dyadic interaction.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Siebner, H. R., Elsner, B., Hommel, B., Mentschel, C., Prinz, W., & Conrad, B. (2001, September). *Die Verknüpfung von Handlungen und ihren Konsequenzen im menschlichen Gehirn: eine $H_2{}^{15}O$-PET-Aktivierungsstudie [Linking actions and their consequences in the human brain: a $H_2{}^{15}O$-PET study].* 74. Kongress der Deutschen Gesellschaft für Neurologie, Aachen.

Splett, T. (2001, September). *Was spiegeln Monaden? Zur Rolle der Spiegelmetapher für die Monadenlehre und das Atomismus/Holismus-Problem [What is mirrored by monads? Mirror metaphor's role in monadology and the atomism/holism problem].* VII. Internationaler Leibniz-Kongreß 'Nihil sine ratione', Gottfried-Wilhelm-Leibniz Gesellschaft Hannover e.V.; Berlin-Brandenburgische Akademie der Wissenschaften, Technische Universität Berlin.

Splett, T. (2002, May). *Semantische Auf- und Abstiege zur Wirklichkeit. Was es heißen kann, einem metaphysischen Problem durch Analyse der Sprache beizukommen: meaning is use in der Realismusdebatte [Semantic ascents and descents to reality. What it could mean to cope with a metaphysical problem by analyzing language: Meaning is use in the realism debate].* Universität Konstanz.

Splett, T. (2002, November). *Was erbringt die Beschäftigung mit physikalischem Determinismus für die Verständigung über Freiheit und Verantwortung? [What does thinking about physical determinism contribute to understanding freedom and responsibility?].* Symposium 'Determinismus und Freiheit in der Physik und der Philosophie', Universitas-Förder-Initiative der Hanns Martin Schleyer-Stiftung und Heinz Nixdorf Stiftung, Iffeldorf.

Splett, T. (2003, February). *Does the will exist?* Munich Philosophical Lecture Series on the Nature and Culture of Volition, Max-Planck-Institut für Psychologische Forschung, München.

Splett, T. (2003, March). *Kommuniziert Kunst? [Does art communicate?].* Kunstverein, Gelsenkirchen.

Splett, T. (2003, November). *Grundloses Wollen [Willing without motives].* Symposium 'Freiheit in Physik und Philosophie', Universitas-Förder-Initiative der Hanns Martin Schleyer-Stiftung und Heinz Nixdorf Stiftung, Weimar.

Stenneken, P. (2001, November). *Die zeitliche Steuerung von Handlungen: Eine vergleichende Studie mit einem deafferentierten Patienten [Temporal control of actions: A comparative study with a deafferented patient].* Forschungskolloquium 'Allgemeine und Experimentelle Psychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

Stenneken, P., Aschersleben, G., Cole, J., & Prinz, W. (2001, March). *Temporal control of movements by their intended outcome: A comparative study with a deafferented patient.* Symposium 'Neural control of space coding and action production', Lyon, France.

Stenneken, P., Aschersleben, G., Cole, J., & Prinz, W. (2001, April). *Zeitliche Steuerung von Bewegungen: Eine Fallstudie mit einem deafferentierten Patienten [Temporal control of movements: A case study with a deafferented patient].* 43. Tagung experimentell arbeitender Psychologen (Teap), Regensburg.

Stenneken, P., Aschersleben, G., Cole, J., & Prinz, W. (2001, October). *Action timing and sensory loss: The prediction of sensory consequences.* Fourth Summer School of the European Diploma of Cognitive and Brain Sciences, Teneriffa, Spain.

Stenneken, P., Aschersleben, G., Cole, J., & Prinz, W. (2001, November). *The relevance of proprioception in action timing studied in a case of deafferentation.* 42nd Annual Meeting of the Psychonomic Society, Orlando, FL.

Stenneken, P., Aschersleben, G., Cole, J., & Prinz, W. (2002, March). *'How can I model in my head the repeat movement?' The timing of actions in a case of somatosensory deafferentation.* Symposium 'Neural control of space coding and action production', Poitiers, France.

Stenneken, P., Aschersleben, G., Cole, J., & Prinz, W. (2002, March). *Zeitliche Steuerung von Handlungen durch die Vorhersage ihrer sensorischen Konsequenzen? [Timing movements by predicting their sensory consequences?].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Stenneken, P., Aschersleben, G., Cole, J., & Prinz, W. (2002, September). *Die zeitliche Steuerung von Bewegungen: Wahrgenommene vs. vorhergesagte sensorische Handlungskonsequenzen [The temporal control of movements: Perceived vs. predicted sensory consequences of actions].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Stenneken, P., Cole, J., Paillard, J., & Aschersleben, G. (2003, March). *Antizipative Steuerung von Bewegungen bei Probanden mit somatosensorischen Ausfällen [Anticipatory control of movements in participants with somatosensory deficits].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Stenneken, P., Cole, J., Paillard, J., & Aschersleben, G. (2003, July). *Coordinating movements in time: The role of sensory movement consequences.* Joint meeting of the International Neuropsychological Society (INS) and the Gesellschaft für Neuropsychologie (GNP), Berlin.

Stork, S., & Müsseler, J. (2001, November). *Saccadic eye movements and mislocalizations of briefly presented stimuli.* 42nd Annual Meeting of the Psychonomic Society, Orlando, FL.

Stork, S., & Müsseler, J. (2002, March). *Lokalisations- und Sakkadengenauigkeit bei kurzzeitig dargebotenen Reizen [The accuracy of localizations and eye movements with briefly presented stimuli].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Stork, S., & Müsseler, J. (2002, November). *Saccadic undershoots and the relative localization of stimuli.* Workshop 'Dynamic Perception', Ruhr-Universität Bochum.

Stork, S., Müsseler, J., & Neggers, S. F. W. (2001, March). *Der Einfluss von Blickbewegungen auf Lokalisationsfehler am Bewegungsende [The influence of eye movements on localization errors at the end of a movement].* 4. Tübinger Wahrnehmungskonferenz (TWK 2001), Tübingen.

Contributions to Congresses and Invited Lectures

Stork, S., Müsseler, J., & Neggers, S. F. W. (2001, April). *The influence of eye movements on the perceived vanishing point of a moving stimulus.* EuroConference on Cerebellar and Cortical Control of Eye Movements: Three-Dimensional Sensory and Motor Space, Granada, Spain.

Stork, S., Müsseler, J., & Neggers, S. F. W. (2001, August). *Action control affects the perceived vanishing point of a moving stimulus.* 24th European Conference on Visual Perception (ECVP 2001), Kusadasi, Turkey.

Stork, S., Müsseler, J., & Neggers, S. F. W. (2001, September). *Eye movements and the perceived vanishing point of a moving stimulus.* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

Stottmeister, F., Knoblich, G., & Kircher, T. T. J. (2003, April). *Disturbed self-monitoring of action is correlated with hallucinations and formal thought disorder.* IXth International Congress on Schizophrenia Research, Colorado Springs, CO.

T

Töllner, T., Weigelt, M., Rieger, M., & Mechsner, F. (2003, March). *Bimanuelle Bewegungen aus gleichen und unterschiedlichen Ausgangspositionen: Parametrisierung vs. Zielkodierung [Bimanual coordination out of equal and unequal starting positions: Parameterization vs. target coding].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

V

Vierkant, T. (2001, June). *Zombie Mary.* 5th Annual Meeting of the Association for the Scientific Study of Consciousness, Duke University, UK.

Vierkant, T. (2002, May). *Gibt es 'das' Selbst: Zwei Unterscheidungen für ein besseres Verständnis eines undurchsichtigen Begriffs [Does 'the' self exist? Two distinctions for better understandig a fuzzy term].* Forschungskolloquium 'Allgemeine und Experimentelle Psychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

Vierkant, T. (2002, June). *Free will, three kinds of selves, and moral realism.* Symposium 'On the Social Significance of the Will', München.

Vierkant, T. (2002, July). *Is there a self?* Annual Meeting of the European Society for Philosophy and Psychology, Lyon, France.

Vierkant, T. (2003, February). *Responsibility, orthonomy and consciousness.* Munich Philosophical Lecture Series on the Nature and Culture of Volition, Max-Planck-Institut für Psychologische Forschung, München.

Vierkant, T. (2003, June). *Konzepte des Selbst und moralischer Realismus [Three concepts of self and moral realism].* 7. Berliner Junitagung für Forensische Psychiatrie und Psychologie: Hirnforschung, Willensfreiheit und strafrechtliche Verantwortung, Institut für Forensische Psychiatrie, Berlin.

Vierkant, T. (2003, July). *Owning intentions.* Annual Meeting of the European Society for Philosophy and Psychology, Fondatione Roselli, Torino, Italy.

W

Walde, B. (2002, May). *The metaphysics of modality and the failure of reductive explanation.* 6th Meeting of the Association for the Scientific Study of Consciousness, Barcelona, Spain.

Walde, B. (2002, September). *Materialismus und metaphysische Möglichkeit [Materialism and metaphysical possibility].* Tagung der Allgemeinen Gesellschaft für Philosophie in Deutschland, Bonn.

Wascher, E. (2001, February). *Automatische Reaktionsaktivierung ausgelöst durch bewegte Punktemuster [Automatic response activation released by moving-dot patterns].* 4. Tübinger Wahrnehmungskonferenz (TWK 2001), Tübingen.

Wascher, E. (2001, March). *Automatic response activation evoked by directional information.* 8th Annual Meeting of the Cognitive Neuroscience Society, New York, NY.

Wascher, E. (2001, April). *Spatial parameters in perception and action. A psychophysiological approach.* University of Casimirus the Great, Bydgoszcz, Poland.

Wascher, E. (2001, April). *Wahrnehmungsbeschleunigung durch Reaktionsvorbereitung [Facilitation of perception by response preparation].* 43. Tagung experimentell arbeitender Psychologen (Teap), Regensburg.

Wascher, E. (2001, May). *Räumliche Kodes in Wahrnehmung und Handlung: Psychophysische Evidenz für unterscheidbare Mechanismen in der Informationsübertragung [Spatial codes in perception and action].* Forschungskolloquium 'Theoretische und experimentelle Kognitionspsychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

Wascher, E. (2001, May). *Wo, Was, Wie, Wann? Neues von zwei Pfaden [Where, what, how, when? News about two pathways].* Arbeitstreffen DFG-Schwerpunktptogramm 1001 'Sensumotorische Intergration': Metacontrast, Sensorimotor Integration, and Attentional Selection, Universität Bielefeld.

Wascher, E. (2002, March). *Intraindividuelle Analyse dynamischer Effekte in der Simon Aufgabe [Intraindividual analysis of dynamic effects in the Simon task].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Wascher, E. (2002, April). *Inhibition of return: An EEG Study.* 9th Annual Meeting of the Cognitive Neuroscience Society, San Francisco, CA.

Wascher, E. (2002, June). *Zwei Wege vom Reiz zur Reaktion? [Two routes from the stimulus to the response?].* Institut für Psychologie, Universität Gießen.

Wascher, E. (2002, September). *Ein neuro-kognitiver Ansatz zu Wahrnehmungs-Handlungsbeziehungen [A neuro-cognitive approach to perception-action relations].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Wascher, E. (2003, February). *ERP correlates of visual-spatial attention.* 6. Tübinger Wahrnehmungskonferenz (TWK 2003), Tübingen.

Wascher, E. (2003, May). *Cortical asymmetries as an indicator for the timing of visual spatial processing.* Department of Neurological and Visual Sciences, University of Verona, Italy.

Wascher, E. (2003, May). *Dynamic aspects of spatial S-R correspondence.* Department of General Psychology, University of Padova, Italy.

Wascher, E. (2003, May). *Wie kommt Information vom Auge zur Hand. Dynamische Aspekte visuo-motorischer Prozesse [How does information get from the eye to the hand. Dynamic models of visuo-motor processing].* Fachbereich Psychologie, Universität Trier.

Wascher, E. (2003, November). *An integrative approach to human information processing.* Workshop 'General Theory of Information Transfer and Combinatorics', Zentrum für interdisziplinäre Forschung (ZiF), Universität Bielefeld.

Wascher, E. (2003, November). *EEG-Korrelate des Bewusstseins? [EEG-correlates of consciousness].* Institut für Psychologie, Universität Bielefeld.

Wascher, E., & Wiegand, K. (2002, November). *Die Dynamik räumlicher S-R Korrespondenz [The dynamics of spatial S-R correspondence].* Abschlusskolloquium DFG-Schwerpunktprogramm 1001 'Sensumotorische Intergration', Universität Bochum.

Wascher, E., & Wiegand, K. (2003, March). *Der Simon Effekt bei bewegten Reizen [The Simon effect with moving stimuli].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Wascher, E., Wiegand, K., & Grosjean, M. (2003, February). *On the time course of efficient visuo-motor transformation.* 6. Tübinger Wahrnehmungskonferenz (TWK 2003), Tübingen.

Wascher, E., & Wolber, M. (2002, September). *Cortical asymmetries as an indicator for the timing of visual spatial processing.* Symposium 'Visual Space Perception and Action', Ohlstadt.

Waszak, F. (2001, July). *The role of episodic S-R event priming in task-switching.* Forschungskolloquium 'Theoretische und experimentelle Kognitionspsychologie', Max-Planck-Institut für Psychologische Forschung / Ludwig-Maximilians-Universität, München.

Waszak, F. (2002, November). *The role of episodic S-R event priming in task-switching.* Séminaire du Laboratoire de Psychologie Expérimentale. CNRS & Université, Paris, France.

Waszak, F. (2003, September). *Comparing stimulus-triggered reactions and goal-directed actions.* 35th Annual General Meeting of the European Brain and Behaviour Society, Barcelona, Spain.

Waszak, F., Rosenbaum, D. A., Wascher, E., Koch, I., Aschersleben, G., & Prinz, W. (2003, March). *Vergleich von 'reaktiven' und 'operanten' Handlungen anhand von ERPs [Comparison of 'reactive' and 'operant' actions using ERPs].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Weigelt, M. (2001, May). *Attentional focus on supra-postural tasks affects balance learning.* Department of Psychology, University of Reading, UK.

Weigelt, M. (2002, November). *Re-examining the role of parameter specification in bimanual coordination.* Workshop 'Perception and Action', Universität Bamberg.

Weigelt, M. (2003, June). *Wenn experimentelle Psychologie auf Sportpädagogik trifft: Untersuchungen zum Bewegungslernen [Experimental psychology meets sport pedagogy: Studies on motor learning].* Arbeitstagung Sportpädagogik, Weimar.

Weigelt, M. (2003, August). *Conceptual organization in bimanual coordination.* Universidade Estadual Paulista, Movement Science Faculty, Río Claro, Brasil.

Weigelt, M. (2003, September). *Conceptual prganization in bimanual coordination.* Universidade de São Paulo, Sport Science Institute, São Paulo, Brasil.

Weigelt, M. (2003, November). *Bimanuelle Koordination in Patienten mit spiegelsymmetrischer Mitbewegung.* Bimanual coordination in patients with mirror-symmetry, Lehrstuhl für Kognitive Neurologie, Universitätsklinikum München.

Weigelt, M., & Bunker, L. K. (2002, March). *Practice variability effects on bilateral transfer for a novel ball-bouncing task.* Interdisziplinäres Kolleg 2002, Günne am Möhnesee.

Weigelt, M., & Bunker, L. K. (2002, April). *Practice variability on bilateral transfer.* National Convention of the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD), San Diego, CA.

Weigelt, M., & Bunker, L. K. (2002, May). *Kontralateraler Transfer und Variabilität der Trainingsgestaltung [Contralateral transfer and variability of practice].* 34. Tagung der Arbeitsgemeinschaft für Sportpsychologie, Münster.

Weigelt, M., Mechsner, F., Rieger, M., & Prinz, W. (2002, July). *Symmetry constraints on bimanual coordination - An action-perception perspective.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kochel, Germany.

Weigelt, M., Mechsner, F., Rieger, M., & Prinz, W. (2003, March). *Wie sich die Dimension des Stimulus auf die Planung bimanueller Bewegungen auswirkt [Stimulus congruency effects in the planning of bimanual coordination].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Weigelt, M., Mechsner, F., Rieger, M., & Prinz, W. (2003, September). *Stimulus congruency in the planning of bimanual movements.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Weigelt, M., Rieger, M., Mechsner, F., & Prinz, W. (2003, July). *Symbolic target cueing effects in bimanual coordination.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kloster Nimbschen, Grimma.

Weigelt, M., & Schack, T. (2002, May). *Symposium Kognitive Repräsentation und Bewegungslernen: Einleitung [Symposium on cognitive representations and motor learning: Introduction].* 34. Tagung der Arbeitsgemeinschaft für Sportpsychologie, Münster.

Weigelt, M., Senff, O., Kirchner, G., & Schack, T. (2003, January). *Mit links besser lernen? [Is learning better on the left-hand side?].* 8. Symposium der dvs-Sektion Sportmotorik 'Transferphänomene in der Motorik', Bremen.

Weigelt, M., & Wulf, G. (2001, June). *Attentional focus on suprapostural tasks and its effect on balance.* 1st World Congress on Motor Development and Learning in Infancy, Amsterdam, NL.

Weigelt, M., & Wulf, G. (2002, March). *Dem Gleichgewicht unter die Arme greifen [To help out balance].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Weinert, F. E. (2001, January). *Die evaluierte Universität [The evaluated university].* Heidelberger Universitätsvorlesungen, Universität Heidelberg.

Weinert, F. E. (2001, January). *Für und Wider die neuen pädagogisch-psychologischen Lerntheorien [Pros and cons of the new learning theories in educational psychology].* Symposium New Media, Complex Methods, Wirtschaftsuniversität Wien, Austria.

Werheid, K., Koch, I., Braß, M., Reichert, K., & von Cramon, D. Y. (2002, September). *Aufgabenwechsel bei Parkinsonpatienten: Welchen Einfluss haben exogene und endogene Hinweisreize? [Task switching in Parkinson patients: What influence do exogenous and endogenous cues have ?].* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Wiegand, K., & Wascher, E. (2002, February). *Elektrophysiologische Korrelate dynamischer Reize im Simon Paradigma [EEG correlates of dynamical stimuli in the Simon paradigm].* 5. Tübinger Wahrnehmungskonferenz (TWK 2002), Tübingen.

Wiegand, K., & Wascher, E. (2002, March). *Dissoziation horizontaler und vertikaler S-R Kompatibilität [Dissociation of horizontal and vertical S-R compatibility].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Wiegand, K., & Wascher, E. (2003, February). *Die Dissoziation horizontaler und vertikaler Korrespondenzphänomene [Dissociation of horizontal and vertical correspondence].* 6. Tübinger Wahrnehmungskonferenz (TWK 2003), Tübingen.

Wiegand, K., & Wascher, E. (2003, March). *Temporale Unterschiede horizontaler und vertikaler Informationsverarbeitung im Simon Paradigma [Temporal differences in processing horizontal and vertical spatial information in the Simon paradigm].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Wohlschläger, A. (2001, January). *Gehirn und Handlung [Brain and action].* Münchner Volkshochschule Zentrum, München.

Wohlschläger, A. (2001, February). *Handlungsabhängige Wahrnehmung oder die Intentionalität in Handlung und Wahrnehmung [Action-dependent perception or intentionality in action and perception].* Universität Passau.

Wohlschläger, A. (2001, February). *Wahrnehmung und Gehirn [Perception and brain].* Münchner Volkshochschule am Hart, München.

Wohlschläger, A. (2001, June). *Vorstellung, Wahrnehmung, Handlung und die mentale Rotation [Imagery, perception, action, and mental rotation].* Katholische Universität, Eichstätt.

Wohlschläger, A. (2001, July). *Imagery and action goals.* 8th European Workshop on Imagery and Cognition, Saint Malo, France.

Wohlschläger, A. (2001, September). *Ideomotor theories of imitation: Developmental evidence.* Joint Workshop 'Motor and Cognitive Bases of Imitation', Institute of Cognitive Neuroscience and Institute of Movement Neuroscience, University College London, UK.

Wohlschläger, A. (2001, September). *The perceived time of self- and other-generated actions.* 2nd Lyon-Munich-Workshop, Max-Planck-Institut für psychologische Forschung, München.

Contributions to Congresses and Invited Lectures

Wohlschläger, A. (2001, November). *Wahrnehmung und Gehirn [Perception and brain].* Münchner Volkshochschule am Harras, München.

Wohlschläger, A. (2001, November). *Zur Rolle von Handlungszielen bei der Wahrnehmung, Vorstellung und Ausführung von Drehbewegungen [The role of action goals in perception, imagination, and execution of rotatory movements].* Deutsche Gesellschaft für Psychiatrie, Psychotherapie und Nervenheilkunde, Kongress 2001, Berlin.

Wohlschläger, A. (2001, December). *Zur Rolle von Zielen bei der Handlung, Wahrnehmung, Vorstellung und Imitation [The role of goals in action, perception, imagery, and imitation].* Institut für Medizin, Forschungszentrum Jülich.

Wohlschläger, A. (2002, February). *Die Rolle von Handlungszielen bei der visuellen Wahrnehmung, Vorstellung und Ausführung von Drehbewegungen [The role of action goals in visual perception, imagination, and execution of rotatory movements].* Fakultät für Psychologie, Arbeitseinheit Biopsychologie, Ruhr-Universität Bochum.

Wohlschläger, A. (2002, April). *The role of goals in perception, action, and imagery.* University of Bangor, UK.

Wohlschläger, A. (2002, May). *The role of goals in perception, action, and imagery.* Symposium 'Perception and Action: questions!', Università degli Studi di Ferrara, Italy.

Wohlschläger, A. (2002, October). *Agency as a constituting condition for the own self - and other selves.* Symposium 'Self and Action', Ohlstadt.

Wohlschläger, A. (2002, November). *Der freie Wille - eine Illusion? Neue Erkenntnisse aus der Hirnforschung [The free will - an illusion? New insights from brain research].* Münchner Volkshochschule am Gasteig, München.

Wohlschläger, A. (2003, March). *Der freie Wille – eine Illusion? Neue Erkenntnisse der Hirnforschung [The free will - an illusion? New insights from brain research].* Münchner Volkshochschule Pasing, München.

Wohlschläger, A. (2003, March). *Neural correlates of top-down influences on apparent motion.* Institut für Medizin, Forschungszentrum Jülich.

Wohlschläger, A. (2003, April). *Agency as a constituting condition for the own self - and other selves.* Symposium 'Self Representation', Hanse-Wissenschaftskolleg, Delmenhorst.

Wohlschläger, A. (2003, September). *Agency as a constituting condition for the own self - and other selves.* 13th Conference of the European Society for Cognitive Psychology (ESCoP XIII), Granada, Spain.

Wohlschläger, A. (2003, November). *Der freie Wille - eine Illusion? Neue Erkenntnisse der Hirnforschung [The free will - an illusion? New insights from brain research].* Münchner Volkshochschule am Harras, München.

Wohlschläger, A., Ritzl, A., Vogeley, K., Schilbach, L., Zilles, K., & Fink, G. R. (2003, June). *Neural correlates of top-down influences on apparent motion perception.* 9th Annual Meeting of the Organization for Human Brain Mapping (HBM 2003), New York, NY.

Wolber, M. (2002, July). *Salienzdetektion in einer visuellen Suchaufgabe [Target saliency detection in visual search].* Tutorials in Behavioural and Brain Sciences (TuBBS), Kochel.

Wolber, M., Kiss, M., & Wascher, E. (2003, March). *Kortikale Asymmetrien reflektieren den Zeitverlauf visuell-räumlicher Verarbeitung [Cortical asymmetries reflect the timing of visual-spatial processing].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Wolber, M., Kiss, M., & Wascher, E. (2003, May). *Cortical asymmetries as an indicator of timing of visual spatial processing.* 10th Annual Meeting of the Cognitive Neuroscience Society, New York, NY.

Wolber, M., Kiss, M., & Wascher, E. (2003, June). *Psychophysiological evidence for a salience detection mechanism in visual search tasks.* Munich Visual Search Symposium, Holzhausen am Ammersee.

Wolber, M., Neeb, B., & Wascher, E. (2001, February). *Ereigniskorrelierte Lateralisierungen als Indikatoren paralleler und serieller Prozesse in einer visuellen Suche [Event-related lateralisations as an index of parallel and serial processes in a visual search task].* 4. Tübinger Wahrnehmungskonferenz (TWK 2001), Tübingen.

Wolber, M., Neeb, B., & Wascher, E. (2001, March). *Event-related lateralisations as an index of parallel and serial processing in visual search.* 8th Annual Meeting of the Cognitive Neuroscience Society, New York, NY.

Wolber, M., Neeb, B., & Wascher, E. (2001, April). *EEG-Lateralisierungen als Indikatoren für parallele und serielle Prozesse [EEG lateralisations as an index of parallel and serial processes].* 43. Tagung experimentell arbeitender Psychologen (Teap), Regensburg.

Wolber, M., & Wascher, E. (2002, February). *Lokalisationsprozesse werden von Ereigniskorrelierten Lateralisierungen reflektiert [Event related lateralizations as indicators of spatial location selection].* 5. Tübinger Wahrnehmungskonferenz (TWK 2002), Tübingen.

Wolber, M., & Wascher, E. (2002, March). *Aufmerksamkeitsprozesse in Abhängigkeit der Salienz in der visuellen Suche [Attentional processes are dependent on saliency in visual search tasks].* 44. Tagung experimentell arbeitender Psychologen (TeaP), Chemnitz.

Wriessnegger, S., & Wascher, E. (2002, March). *Subliminal perception and motor priming.* Interdisziplinäres Kolleg 2002, Günne am Möhnesee.

Wriessnegger, S., & Wascher, E. (2002, July). *Subliminal perception and motor activation: An EEG study.* Tutorials in Behavioural and Brain Sciences (TuBBS), Kochel.

Wriessnegger, S., & Wascher, E. (2003, February). *Temporale Effekte visueller Informationsverarbeitung bei subliminaler Wahrnehmung: Eine EEG-Studie [Temporal effects of subliminal visual information processing: An EEG study].* 6. Tübinger Wahrnehmungskonferenz (TWK 2003), Tübingen.

Wriessnegger, S., & Wascher, E. (2003, March). *Zeitliche Faktoren visueller Informationsverarbeitung in einem Metakontrastparadigma. [Temporal effects of visual information processing in metacontrast].* 45. Tagung experimentell arbeitender Psychologen (TeaP), Kiel.

Wriessnegger, S., & Wascher, E. (2003, July). *The N2pc as a correlate of conscious perception?* Tutorials in Behavioural and Brain Sciences (TuBBS), Kloster Nimbschen, Grimma.

Wühr, P., & Müsseler, J. (2001, February). *Assoziierte Reaktionen erleichtern die Identifikation visueller Reize [Associated reactions facilitate the identification of visual stimuli].* 4. Tübinger Wahrnehmungskonferenz (TWK 2001), Tübingen.

Wühr, P., & Müsseler, J. (2001, April). *Einfluss von Wahlreaktionen auf die gleichzeitige Identifikation reaktions-assoziierter Buchstaben [The impact of choice reactions on the simultaneous identification of reaction-associated letters].* 43. Tagung experimentell arbeitender Psychologen (Teap), Regensburg.

Wühr, P., & Müsseler, J. (2001, August). *Costs and benefits in the identification of visual stimuli during the execution of compatible, incompatible, and neutral responses.* 24th European Conference on Visual Perception (ECVP 2001), Kusadasi, Turkey.

Wühr, P., & Müsseler, J. (2001, September). *Does parallel or serial processing cause interference between identical stimuli?* 12th Conference of the European Society for Cognitive Psychology (ESCoP XII) / 18th Annual Conference of the British Psychological Society, Cognitive Psychology Section, Edinburgh, UK.

Wulf, G., Weigelt, M., Poulter, D., & McNevin, N. H. (2002, June). *Attentional focus on supra-postural tasks and its effect on balance.* Annual Meeting of the North American Society for the Psychology of Sport and Physical Activity (NASPSPA), Baltimore, MD.

Wulf, G., Weigelt, M., Poulter, D., & McNevin, N. H. (2002, November). *Attentional focus on supra-postural tasks influences balance learning.* 43rd Annual Meeting of the Psychonomic Society, Kansas City, MO.

Z

Zirngibl, C., & Koch, I. (2002, September). *The impact of response mode on implicit and explicit sequence learning.* 43. Kongress der Deutschen Gesellschaft für Psychologie (DGPs), Berlin.

Appointments and Awards

Knut Drewing was awarded the *Otto-Hahn-Medal for Junior Scientists* in the Max Planck Society for his dissertation *Die Rolle sensorischer Reafferenzen bei der zeitlichen Steuerung von Handlungen* [A role for sensory reafference in the timing of actions]. (June 2003).

Thomas Goschke declined a chair as Professor for Experimental Psychology II at the Universität Osnabrück (July 2001). He accepted a chair as *Full Professor for Experimental Psychology* at the Technische Universität Dresden (as of April 2002).

Petra Hauf was awarded a prize for the *Best Talk at the Second Dissertation Contest* of the FG Allgemeine Psychologie der Deutschen Gesellschaft für Psychologie for her talk *Untersuchungen zum altersspezifischen mehrdimensionalen perzeptiv-kognitiven Urteilsverhalten in der Psychophysik* [Studies on age-specific multidimensional perceptual-cognitive judgments in psychophysics]. (June 2001).

Bianca Jovanovic, Ildiko Kiraly, Gisa Aschersleben, György Gergely, and Wolfgang Prinz were awarded the *Poster Prize* of the 15. Tagung für Entwicklungspsychologie, Potsdam, for their poster *Der Einfluss von Handlungseffekten auf die Wahrnehmung von Handlungszielen bei Säuglingen* [The influence of action effects on the perception of action goals in infants]. (September 2001).

Dirk Kerzel

- was awarded the *Heinz Maier-Leibnitz Preis* by the Deutsche Forschungsgemeinschaft (DFG). (May 2003)
- received a *Heisenberg-Grant* from the Deutsche Forschungsgemeinschaft at the Justus-Liebig-Universität Giessen (starting August 2002).

Sabine Maasen accepted *a chair for Sociology of Science/Science Studies* at the Universität Basel, Switzerland (as of September 2001).

Franz Mechsner was granted the second prize in the *Wolfgang Metzger Award* 2002 contest by the International Society for Gestalt Theory and its Applications. (May 2002).

Ralf Möller accepted a position as *Full Professor in Technical Informatics* at the Universität Bielefeld. (July 2003).

Jochen Müsseler was awarded the title of an *unscheduled professor* at the Ludwig-Maximilians-Universität München (as of August 2003).

Gertrud Nunner-Winkler was awarded the title of an *unscheduled professor* at the Ludwig-Maximilians-Universität München (as of June 2001).

Prisca Stenneken was awarded a prize for the *Best Dissertation at the Third Dissertation Contest* of the FG Allgemeine Psychologie der Deutschen Gesellschaft für Psychologie: *Die zeitliche Steuerung von Handlungen: Eine vergleichende Studie mit einem deafferentierten Patienten* [The temporal control of actions: A comparative study with a deafferented patient]. (June 2003).

Florian Waszak was awarded the *Otto-Hahn-Medal for Junior Scientists* in the Max Planck Society for his dissertation *Task-switching and long-term priming: Role of episodic S-R bindings in task-shift costs.* (June 2002).

Memberships in Scientific Institutions, Committees, and Editorial Boards

Thomas Goschke

- Member of the Teaching Committee, *International Cognitive Science Program, Universität Osnabrück*

Frank Halisch

- Co-editor, series Motivationsforschung

Günther Knoblich

- Member of the Advisory Board, *Gesellschaft für Kognitionswissenschaft*
- Member of the ZIF Network of Young Scientists, *Zentrum für interdisziplinäre Forschung (ZIF), Bielefeld*

Iring Koch

- Local Officer for Germany, *European Society for Cognitive Psychology (ESCoP)*

Rafael Laboissière

- Member of the Advisory Council of *Attention & Performance*

Sabine Maasen

- Member of the Editorial Board, *Yearbook Sociology of the Sciences*

Gertrud Nunner-Winkler

- Member of the Commission, *Ethik-Kommission der Deutschen Gesellschaft für Soziologie*
- Member of the Scientific Board, *Journal für Konflikt- und Gewaltforschung*
- Member of the Scientific Board, *Kriminologisches Forschungsinstitut Niedersachsen*
- Member of the Scientific Board, *Kulturwissenschaftliches Institut, Essen*
- Member of the Editorial Board, *Leviathan*
- Member of the Scientific Board, *Otto-Friedrich-Universität Bamberg*
- Member of the Editorial Board, *Soziologische Revue*, Coeditor
- Member of the jury forwarding the *Thyssen-Preis* for the three best articles in German-speaking sociological journals
- Member of the Scientific Board, *Zeitschrift für Soziologie*
- Member of the Scientific Board, *Zeitschrift EuS – Ethik und Sozialwissenschaften*

Prinz, Wolfgang

- Member of the *Academia Europaea*
- Executive Committee Member, *International Association for the Study of Attention and Performance (IASAP)*
- Member of the Scientific Advisory Board, *Center of Learning and Multimodal Communication, University of Chicago, USA*
- Member of the Advisory Board to the Dean of the *School of Humanities and Social Sciences, International University Bremen (IUB)*
- Member of the Scientific Advisory Board, *European Society for Cognitive Psychology (ESCoP)*
- Member of the Editorial Board, *Interaction Studies*
- Member of the *Academia Leopoldina, Halle*
- Chair of the Advisory Board, *Minerva Max-Wertheimer-Center for Cognitive Processes and Human Performance, Haifa, Israel*
- Member of the Scientific Advisory Board, *Zentrum für interdisziplinäre Forschung (ZiF), Bielefeld*
- Associate Editor, *European Journal of Cognitive Psychology*
- Consulting Editor, *Psychological Review*

Professoral Habilitations, Doctoral Dissertations, Diploma and Master's Theses

Professoral Habilitations

Kerzel, D. (2002). *„Representational momentum": Dynamik repräsentierender Prozesse, nicht Dynamik mentaler Repräsentationen. [„Representational Momentum": Dynamics of representing processing, not dynamic mental representations].* Ludwig-Maximilians-Universität München.

Koch, I. (2003). *Kognitive Koordination von Aufgaben. [Cognitive coordination of tasks].* Ludwig-Maximilians-Universität München.

Maasen, S. (2001). *Dynamics of knowledge.* Universität Bielefeld.

Möller, R. (2001). *A biorobotics approach to the study of visual homing strategies.* Universität Zürich, Switzerland.

Doctoral Dissertations

de Maeght, S. (2002). *New insights in ideomotor action: Investigating the influence of perception, motor, and intention representation.* Ludwig-Maximilians-Universität München.

Deubzer, E. (2003). *Die Ordnung im Kopf – Begriffliche Wissensstrukturen zur Entwicklung benutzerorientierter Anordnungen von Funktionen im Raum. [Order in the head – Conceptual knowledge structures for developing user-oriented arrangements of functions in space].* Technische-Universität München.

Drewing, K. (2001). *Die Rolle sensorischer Reafferenzen bei der zeitlichen Steuerung von Handlungen. [A role for sensory reafference in the timing of actions].* Ludwig-Maximilians-Universität München.

Flach, R. (2002). *On the specifity of action perception: An action-based approach.* Ludwig-Maximilians-Universität München.

Jovanovic, B. (2003). *The development of self and intentional understanding in infancy.* Ludwig-Maximilians-Universität München.

Nißlein, M. (2001). *Über das Entdecken von Buchstaben und das Verstehen von Sätzen: Experimentelle Untersuchungen zu kognitiven Verarbeitungsmechanismen beim Lesen von Texten. [Letter detection and sentence processing: Experimental studies on cognitive processing in reading texts].* Ludwig-Maximilians-Universität München.

Pollok, B. (2002). *Neuromagnetische Korrelate der zeitlichen Steuerung einfacher motorischer Handlungen. [Neuromagnetic correlates of timing of simple motor actions].* Ludwig-Maximilians-Universität München.

Stenneken, P. (2002). *Die zeitliche Steuerung von Handlungen. Eine vergleichende Studie mit einem deafferentierten Patienten. [The temporal control of movements: A comparative study with a deafferented patient].* Ludwig-Maximilians-Universität München.

Stork, S. (2002). *Blickbewegungen und die Lokalisation von stationären und bewegten Reizen. [Eye movements and the localization of stationary and moving stimuli].* Ludwig-Maximilians-Universität München.

Vierkant, T. (2002). *Is the self real?* Ludwig-Maximilians-Universität München.

Walde, B. (2001). *Metaphysik des Bewusstseins – Ein naturalistischer Erklärungsansatz. [The metaphysics of consciousness – A naturalistic approach].* Ludwig-Maximilians-Universität München.

Waszak, F. (2001). *Task switching and long-term priming: Role of episodic S-R bindings in task-shift costs.* Ludwig-Maximilians-Universität München.

Diploma Theses

Bach, P. (2001). *Action comprehension: The case of paper, scissors, rock.* Ludwig-Maximilians-Universität München. (Knoblich).

Bardins, S. (2003). *Didaktisches Modell der Theorie der Kleinhirnfunktion nach Franz Mechsner (mit interaktiver Software). [A didactic model of Franz Mechsner's theory of cerebellar function (with an interactive software package)].* Technische Universität München. (Mechsner).

Buhlmann, I. (2002). *Der Einfluss von Hinweisreizen in Simon-Aufgaben: Indikatoren verschiedener Mechanismen der Verarbeitung der vertikalen und horizontalen Dimension. [The influence of cueing in Simon tasks: Indications of different mechanisms in the processing of the horizontal and vertical dimension].* Universität Jena. (Wascher).

Dehler, J. (2003). *Wege der Informationsverarbeitung im impliziten Assoziationstest (IAT). [Ways of information processing in the implicit association test].* Friedrich-Alexander-Universität Erlangen-Nürnberg. (Knoblich).

Drost, U. C. (2001). *Control of multiple actions: How people play "paper, scissors, rock" against themselves.* Friedrich-Alexander-Universität Erlangen-Nürnberg. (Knoblich).

Öllinger, M. (2001). *Sequenzlernen bei koordinierten Handlungen. [Sequence learning with coordinated actions].* Ludwig-Maximilians-Universität München. (Knoblich).

Master's Theses

Hove, M. (2002). *Perceptual and neuro-muscular-skeletal constraints on motor control and learning.* Ludwig-Maximilians-Universität München. (Mechsner).

Zirngibl, C. (2001). *Implicit learning: Empirical and pedagogical issues.* Ludwig-Maximilians-Universität München. (Koch).

Postgraduate Training and the Promotion of Young Scientists

Apart from providing individual supervision of dissertation projects by senior researchers, the Institute runs a variety of regular courses for postgraduate students:

Literature seminars

Once every 2 weeks during the university semester, a senior researcher offers a lecture seminar on topics from cognitive science or neuroscience. The underlying idea is to provide a critical forum for discussing current theoretical trends.

Postgraduate student colloquium

Twice a year, a 2- to 3-day postgraduate student colloquium is held outside the Institute at which PhD students present their dissertation projects and invite discussion. This seminar is run by Wolfgang Prinz, Günther Knoblich and Edmund Wascher.

Tutorials in Behavior and Brain Sciences (TuBBS)

TuBBS is an interdisciplinary summer school for PhD students attending the Max Planck Institutes of Cognitive Neuroscience (Leipzig), Evolutionary Anthropology (Leipzig), Psycholinguistics (Nijmegen), and Psychological Research (Munich). Leading scientists offer courses and workshops on topics going beyond the special field of interest at each institution. The PhD students at the Max Planck Institutes present their research at poster sessions.

Lunch sessions

Once a week, senior and junior researchers have lunch together followed by a discussion of current research work in an informal atmosphere.

Research colloquium on Theoretical and Experimental Psychology (FoKo)

This is a series of meetings organized jointly by the Max Planck Institute for Psychological Research and the Department of Experimental Psychology (Ludwig-Maximilians-Universität München). Once a week, national and international experts present papers on current themes in cognitive psychology. This colloquium can also be used to present and discuss dissertations before a broader audience.

Courses Given by Institute Members

A

Aschersleben, G., & Elsner, B. *Entwicklung der Handlungssteuerung bei Kleinkindern [Development of action control in infants].* (Ludwig-Maximilians-Universität München, summer term 2001).

Aschersleben, G., & Elsner, B. *Imitation in den ersten drei Lebensjahren [Imitation in the first three years of life].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Aschersleben, G., & Hauf, P. *Frühe kognitive Entwicklung [Early cognitive development].* (Ludwig-Maximilians-Universität München, summer term 2003).

Aschersleben, G., & Müsseler, J. *Einführung in die statistischen Methoden für Nebenfachstudierende (Begleitseminar zur Vorlesung) [Introductory statistics for students minoring in psychology (Seminar accompanying the lecture)].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

D

Deubel, H., Schneider, W. X., Prinz, W., Müller, H., & Zihl, J. *Forschungskolloquium: Theoretische und Experimentelle Kognitionspsychologie [Research colloquium: Theoretical and experimental cognitive psychology].* (Max-Planck-Institut für Psychologische Forschung/Ludwig-Maximilians-Universität München, summer term 2001).

Drewing, K. *Zeit und Rhythmus [Time and rhythm].* (Ludwig-Maximilians-Universität München, summer term 2002).

Drewing, K., & Waszak, F. *Das Einmaleins der fünf Sinne - Grundlagenseminar zur Wahrnehmungspsychologie [The basics of the five senses - Basic course in perceptual psychology].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

E

Elliott, M. A., Gramann, K., Müller, H., & Prinz, W. *Forschungskolloquium: Allgemeine und Experimentelle Psychologie [Research colloquium: Experimental Psychology].* (Max-Planck-Institut für Psychologische Forschung/Ludwig-Maximilians-Universität München, summer term 2003).

Elsner, B. *Allgemeine Psychologie: Lernen und Motivation [Learning and motivation].* (Technische Universität München, summer term 2002).

Elsner, B., & Hauf, P. *Handlungssteuerung und Handlungsverständnis bei Kleinkindern [Action control and action comprehension in infants].* (Ludwig-Maximilians-Universität München, summer term 2002).

Elsner, B., Wohlschläger, A., Prinz, W., & Müller, H. *Forschungskolloquium: Allgemeine und Experimentelle Psychologie [Research colloquium: Experimental Psychology].* (Max-Planck-Institut für Psychologische Forschung/Ludwig-Maximilians-Universität München, summer term 2002).

Engbert, K. *Psychologische Aspekte im Leistungssport [Psychology of competitive sports].* (Technische Universität München, winter term 2003/2004).

Engbert, K. *Sport in der Prävention und Therapie von Krankheiten - Psychologische Aspekte [Sports in the prevention and rehabilitation of diseases - Psychological aspects].* (Technische Universität München, winter term 2003/2004).

G

Geppert, U. *Motivation und Emotion am Beispiel der Leistungsmotivation [Motivation and emotion illustrated by achievement motivation].* (Universität Erfurt, summer term 2002).

Geppert, U. *Frühkindliche emotionale Entwicklung [Early emotional development].* (Ludwig-Maximilians-Universität München, summer term 2003).

Gramann, K., Elliott, M. A., Müller, H., & Prinz, W. *Forschungskolloquium: Allgemeine und Experimentelle Psychologie [Research colloquium: Experimental Psychology].* (Max-Planck-Institut für Psychologische Forschung/Ludwig-Maximilians-Universität München, winter term 2002/2003).

Grosjean, M., & Knoblich, G. *Literaturseminar für Doktoranden [Graduate literature seminar].* (Ludwig-Maximilians-Universität München, summer term 2003).

J

Jovanovic, B. *Wie lernen Babys sich selbst zu verstehen? [How do babies learn to understand themselves?].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

K

Kerzel, D. *Einführung in die Experimentelle Psychologie (Begleitseminar zur Vorlesung) [Introduction to experimental psychology (Seminar accompanying the lecture)].* (Ludwig-Maximilians-Universität München, summer term 2001).

Kerzel, D. *Lernen und Motivation [Learning and motivation].* (Technische Universität München, summer term 2001).

Kerzel, D. *Experimentalpraktikum [Practical course in experimental psychology].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Kerzel, D., & Müsseler, J. *Statistische Methoden für Nebenfachstudierende [Statistics for students minoring in psychology].* (Ludwig-Maximilians-Universität München, summer term 2001).

Kerzel, D., & Rieger, M. *Statistik für Nebenfachstudierende (Vorlesung) [Statistics for students minoring in psychology (Lecture)].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Knoblich, G. *Literaturseminar für Doktoranden [Graduate literature seminar].* (Ludwig-Maximilians-Universität München, summer term 2001).

Knoblich, G., & Grosjean, M. *Literaturseminar für Doktoranden [Graduate literature seminar].* (Ludwig-Maximilians-Universität München, summer term 2002/2003).

Knoblich, G., & Prinz, W. *Wahrnehmung und Handlungssteuerung. Doktorandenkolloquium [Perception and action control. Colloquium for doctoral students].* (Ludwig-Maximilians-Universität München, summer term 2002).

Knoblich, G., Prinz, W., & Wascher, E. *Wahrnehmung und Handlungssteuerung. Doktorandenkolloquium [Perception and action control. Colloquium for doctoral students].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

Knoblich, G., Prinz, W., & Wascher, E. *Wahrnehmung und Handlungssteuerung. Doktorandenkolloquium [Perception and action control. Colloquium for doctoral students].* (Ludwig-Maximilians-Universität München, summer term 2003).

Knoblich, G., Prinz, W., & Wascher, E. *Wahrnehmung und Handlungssteuerung. Doktorandenkolloquium [Perception and action control. Colloquium for doctoral students].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

Knoblich, G., & Wascher, E. *Literaturseminar für Doktoranden [Graduate literature seminar].* (Ludwig-Maximilians-Universität München, summer term 2002).

Koch, I. *Grundkurs Allgemeine Psychologie: Lernen und Motivieren [Basics of general psychology: Learning and motivation].* (Technische Universität München, summer term 2001).

Koch, I. *Theoretische Sportpsychologie II [Theoretical sports psychology II].* (Technische Universität München, summer term 2001).

Koch, I. *Experimentalpsychologisches Praktikum [Practical introduction to experimental psychology].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Koch, I. *Grundkurs Allgemeine Psychologie: Lernen und Motivieren [Basics of general psychology: Learning and motivation].* (Technische Universität München, summer term 2002).

Koch, I. *Theoretische Sportpsychologie II [Theoretical sports psychology II].* (Technische Universität München, summer term 2002).

Koch, I. *Grundkurs Allgemeine Psychologie: Lernen und Motivieren [Basics of general psychology: Learning and motivation].* (Technische Universität München, summer term 2003).

Koch, I. *Theoretische Sportpsychologie II [Theoretical sports psychology II].* (Technische Universität München, summer term 2003).

Koch, I., & Keller, P. E. *Literaturseminar für Doktoranden [Graduate literature seminar].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

Koch, I., & Knoblich, G. *Literaturseminar für Doktoranden [Graduate literature seminar].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Koch, I., & Philipp, A. M. *Experimentalpsychologisches Praktikum I [Practical introduction to experimental psychology I].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

Koch, I., & Schuch, S. *Experimentalpsychologisches Praktikum [Practical introduction to experimental psychology].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

M

Mechsner, F. *Wahrnehmung, Bewegung und Bewusstsein [Perception, movement, and consciousness].* (Ludwig-Maximilians-Universität München, summer term 2001).

Mechsner, F. *Der bewegte Mensch [Man in motion].* (Ludwig-Maximilians-Universität München, summer term 2002).

Möller, R. *Biomimetische Robotik [Biomimetic robotics].* (Universität Zürich, Switzerland, winter term 2001/2002).

Möller, R. *Biomimetische Robotik [Biomimetic robotics].* (Universität Zürich, Switzerland, winter term 2002/2003).

Müsseler, J. *Einführung in die experimentelle Programmierung mit Matlab [Programming experiments with MATLAB: An introduction].* (Ludwig-Maximilians-Universität München, summer term 2003).

Müsseler, J. *Einführung in die Psychologie der Wahrnehmungs-Handlungs-Zusammenhänge [The psychology of the perception-action relationship: An introductory course].* (Ludwig-Maximilians-Universität München, summer term 2003).

Müsseler, J., & Aschersleben, G. *Einführung in die statistischen Methoden für Nebenfachstudierende (Vorlesung) [Introductory statistics for students minoring in psychology (Lecture)].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

Müsseler, J., & Aschersleben, G. *Sensumotorische Interaktionen [Sensorimotor interactions].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

Müsseler, J., & Rieger, M. *Statistik für Nebenfachstudierende (Übung) [Statistics for students minoring in psychology (Practice course)].* (Ludwig-Maximilians-Universität München, summer term 2002).

N

Nunner-Winkler, G. *Demokratische Systeme und Ziviltugenden [Democratic systems and civil virtues].* (Ludwig-Maximilians-Universität München, summer term 2002).

Nunner-Winkler, G. *Qualitative Methoden [Qualitative research methods].* (Universität Bern, Switzerland, winter term 2002/2003).

Nunner-Winkler, G. *Urteilen Frauen anders? Theorien und Untersuchungen zur geschlechtsspezifischen Moralität [Gender differences in moral judgment - theories and data].* (Universität Fribourg, Switzerland, winter term 2002/2003).

Nunner-Winkler, G. *Identität und Individualität [Identity and individuality].* (Ludwig-Maximilians-Universität München, summer term 2003).

Nunner-Winkler, G. *Qualitative Methoden: Erhebungsverfahren [Qualitative research methods].* (Universität Bern, Switzerland, winter term 2003/2004).

P

Prinz, W., & Knoblich, G. *Wahrnehmung und Handlungssteuerung. Doktorandenkolloquium [Perception and action control. Colloquium for doctoral students].* (Ludwig-Maximilians-Universität München, summer term 2001).

Prinz, W., & Knoblich, G. *Wahrnehmung und Handlungssteuerung. Doktorandenkolloquium [Perception and action control. Colloquium for doctoral students].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

R

Rieger, M. *Die Anwendung kognitiver Paradigmen in der Neuropsychologie [Application of cognitive paradigms in neuropsychology].* (Katholische Universität Eichstätt, summer term 2002).

Rieger, M. *Einführung in die Allgemeine Psychologie: Lernen und Motivation [Introduction to psychology: Learning and motivation].* (Technische Universität München, summer term 2003).

Rieger, M., Grosjean, M., Prinz, W., & Müller, H. *Forschungskolloquium: Allgemeine und Experimentelle Psychologie [Research colloquium: Experimental Psychology].* (Max-Planck-Institut für Psychologische Forschung/Ludwig-Maximilians-Universität München, winter term 2003/2004).

Rieger, M., & Kerzel, D. *Statistik für Nebenfachstudierende (Übung) [Statistics for students minoring in psychology (Practice course)].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Rieger, M., & Müsseler, J. *Statistik für Nebenfachstudierende (Vorlesung) [Statistics for students minoring in psychology (Lecture)].* (Ludwig-Maximilians-Universität München, summer term 2002).

Rieger, M., & Weigelt, M. *Forschungsmethoden: Qualitative und quantitative Methoden (Übung) [Qualitative and quantitative research methods (Practice course)].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

S

Sebanz, N. *Englisch für PsychologInnen [English for psychologists].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Sebanz, N. *Englisch für PsychologInnen [English for psychologists].* (Universität Innsbruck, Austria, winter term 2001/2002).

Splett, T. *Metaphysischer Realismus - Einführung in die zeitgenössische Debatte [Metaphysical realism - An introduction to the contemporary debate].* (Ludwig-Maximilians-Universität München, summer term 2002).

Splett, T. *Heidegger: Einführung in die Metaphysik [Heidegger. Introduction to Metaphysics].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

Splett, T. *Was ist Wille? - Wollen, Wille und Willensfreiheit in der Diskussion [What is the will? - The debate on willing, the will and freedom of the will].* (Ludwig-Maximilians-Universität München, summer term 2003).

Splett, T. *Schopenhauer. Über die vierfache Wurzel des Satzes vom zureichenden Grunde [Schopenhauer. On the fourfold root of the principle of sufficient reason].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

V

Vierkant, T. *Intentionalität: Konzepte zwischen Brentano und Dennett [Intentionality: Concepts from Brentano to Dennett].* (Hochschule für Philosophie München, winter term 2003/2004).

W

Walde, B. *Eine Einführung in die Philosophie David Chalmers' [The philosophy of David Chalmers - An introduction].* (Johannes Gutenberg-Universität Mainz, winter term 2001/2002).

Walde, B. *Die Qualia-Debatte - Eine Einführung [Discussions about qualia - An introduction].* (Johannes Gutenberg-Universität Mainz, summer term 2002).

Walde, B. *Modallogik und Philosophie des Geistes [Modal logic and philosophy of mind].* (Johannes Gutenberg-Universität Mainz, summer term 2002).

Walde, B. *Willensfreiheit - Eine Einführung, Teil I [Free will - An introduction, part I].* (Johannes Gutenberg-Universität Mainz, summer term 2002).

Wascher, E. *Biologische Psychologie I [Biological Psychology I].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Wascher, E. *Psychologie der Informationsverarbeitung [The psychology of information processing].* (Technische Universität München, winter term 2001/2002).

Wascher, E. *Mensch-Maschine Interaktion [Human-machine interaction].* (Technische Universität München, summer term 2002).

Wascher, E. *EEG in der Kognitionsforschung [EEG in cognitive research].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

Wascher, E. *Psychologie der Informationsverarbeitung [The psychology of information processing].* (Technische Universität München, winter term 2002/2003).

Wascher, E. *Mensch-Maschine Interaktion [Human-machine Interaction].* (Technische Universität München, summer term 2003).

Wascher, E. *EEG in der Kognitionsforschung [EEG in cognitive research].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

Wascher, E. *Psychologie der Informationsverarbeitung [The psychology of information processing].* (Technische Universität München, winter term 2003/2004).

Wohlschläger, A. *Methoden der kognitiven Neurowissenschaften [Methods of cognitive neurosciences].* (Katholische Universität Eichstätt, summer term 2001).

Wohlschläger, A. *Gehirn und Bewusstsein [Brain and consciousness].* (Münchner Volkshochschule, winter term 2001/2002).

Wohlschläger, A. *Geschichte der Imitation [The history of imitation].* (Universität Konstanz, winter term 2001/2002).

Wohlschläger, A. *Quantitative Methoden der Psychologie I (Übung) [Quantitative methods in psychology I (Practice course)].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Wohlschläger, A. *Quantitative Methoden der Psychologie I (Vorlesung) [Quantitative methods in psychology I (Lecture)].* (Ludwig-Maximilians-Universität München, winter term 2001/2002).

Wohlschläger, A. *Gehirn und Bewusstsein [Brain and consciousness].* (Münchener Volkshochschule, summer term 2002).

Wohlschläger, A. *Quantitative Methoden der Psychologie II (Übung) [Quantitative methods in psychology II (Practice course)].* (Ludwig-Maximilians-Universität München, summer term 2002).

Wohlschläger, A. *Quantitative Methoden der Psychologie II (Vorlesung) [Quantitative methods in psychology II (Lecture)].* (Ludwig-Maximilians-Universität München, summer term 2002).

Wohlschläger, A. *Quantitative Methoden der Psychologie I (Übung) [Quantitative methods in psychology I (Practice course)].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

Wohlschläger, A. *Quantitative Methoden der Psychologie I (Vorlesung) [Quantitative methods in psychology I (Lecture)].* (Ludwig-Maximilians-Universität München, winter term 2002/2003).

Wohlschläger, A. *Quantitative Methoden der Psychologie II (Übung) [Quantitative methods in psychology II (Practice course)].* (Ludwig-Maximilians-Universität München, summer term 2003).

Wohlschläger, A. *Quantitative Methoden der Psychologie II (Vorlesung) [Quantitative methods in psychology II (Lecture)].* (Ludwig-Maximilians-Universität München, summer term 2003).

Wohlschläger, A. *Quantitative Methoden der Psychologie I (Übung) [Quantitative methods in psychology I (Practice course)].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

Wohlschläger, A. *Quantitative Methoden der Psychologie I (Vorlesung) [Quantitative methods in psychology I (Lecture)].* (Ludwig-Maximilians-Universität München, winter term 2003/2004).

Wohlschläger, A., Elsner, B., Prinz, W., & Müller, H. *Forschungskolloquium: Theoretische und Experimentelle Kognitionspsychologie [Research colloquium: Theoretical and experimental cognitive psychology].* (Max-Planck-Institut für Psychologische Forschung/Ludwig-Maximilians-Universität München, winter term 2001/2002).

Wühr, P. *Einführung in die Experimentelle Psychologie (Begleitseminar zur Vorlesung) [Introduction to experimental psychology (Seminar accompanying the lecture)].* (Ludwig-Maximilians-Universtät München, summer term 2001).

Invited Lectures at the Institute

A

Allport, A., St. Anne's College, Oxford, UK (2001, July). *What Concept of Task-Set? A Few Subversive Observations.*

Ansorge, U., Universität Bielefeld. (2001, July). *Direkte Parameterspezifikation. [Direct Parameter Specification].*

Assad, J., Harvard Medical School, Boston, USA. (2002, April). *Predicting and Perceiving Motion in Parietal Cortex.*

B

Bargh, J., New York University, USA. (2002, July). *The Machine in the Ghost.*

Barr, R., Georgetown University, Washington, DC, USA. (2003, September). *Imitation and Memory: Information Pick-Up and Process.*

Bertelson, P., Free University of Brussels, Belgium. (2001, May). *Audio-Visual Crossmodal Interaction: Some Recent Developments.*

Bieri, P., Freie Universität Berlin. (2001, February). *Schadet die Regie des Gehirns der Freiheit des Willens? [Does the Dominance of the Brain Affect Freedom of the Will?]*

Blakemore, S.-J., University College London, UK. (2003, December). *Self-Monitoring, Delusions of Control and the Human Mirror System.*

Boudreau, J.-P., University of Prince-Edward Island, Charlottetown, Canada. (2001, October). *The Interplay of Attention and Action in Infants' Future-Oriented Behaviours.*

Braß, M., Max-Planck-Institut für Kognitions- und Neurowissenschaften, Leipzig. (2002, July). *Die Rolle des frontalen Kortex bei aufgabenbezogenen Kontrollprozessen. [The Role of Frontal Cortex in Task-Relevant Control Processes].*

Braun, J., University of Plymouth, UK (2003, May). *Attention as a Bottom-Up Process.*

Breitmeyer, B. G., University of Houston, USA. (2002, May). *Visual Masking Reveals the Microgenesis of Unconscious and Conscious Perception.*

Brenner, E., Erasmus University of Rotterdam, NL (2001, November). *Independent Use of Different Kinds of Information Within a Single Task.*

Bridgeman, B., University of California at Santa Cruz, USA. (2003, August). *Interactions of Motor Imagery and Motor Activity in Locomotion.*

Bruce, V., University of Edinburgh, UK (2003, May). *Face and Identity.*

C

Caessens, B., University of Ghent, Belgium. (2001, December). *The Use of Action Effects in Response Control: Insights From Response-Suppression Paradigms.*

Cardoso de Oliveira, S., Universität Dortmund. (2002, October). *Bimanual Coordination Under Visuomotor Transformations.*

Carpenter, M., Max-Planck-Institut für Evolutionäre Anthropologie, Leipzig. (2003, October). *Intention Reading and Imitation.*

Cave, K., University of Verona, Italy. (2001, June). *Making the Most of Spatial Attention.*

Cohen, A., The Hebrew University, Jerusalem, Israel. (2001, July). *Dimensions, Objects, Attention, and Action.*

Cole, J., University of Southampton, UK (2002, September). *The Physiology and Phenomenology of Deafferentation.*

Corballis, M. C., University of Auckland, New Zealand. (2003, July). *From Hand to Mouth: The Origins of Language.*

D

Deco, G., Pompeu Fabra University, Barcelona, Spain. (2003, November). *Neural and Cortical Modeling of Visual Attention, Memory and Reward Learning.*

DeGraf, P., University of Leuven, NL (2001, January). *Transsaccadic Processing of Scene Semantics.*

de'Sperati, C., University of Milan, Italy. (2003, October). *Eye Movements in Imagery.*

Dijksterhuis, A., University of Amsterdam, NL (2001, May). *The Perception-Behavior Expressway: Direct Effects of Social Perception on Social Behavior.*

Dohle, C., Heinrich-Heine Universität Düsseldorf. (2001, June). *Bewegungsstörungen realer und virtueller Arme. [Movement Disturbances in Real and Virtual Limbs].*

Dörner, D., Universität Bamberg. (2002, November). *Die Simulation von Gefühlen oder: Kann man Gefühle berechnen? [The Simulation of Emotions, or: Can Emotions Be Computed?]*

Duncan, J., Medical Research Council, Cambridge, UK (2003, January). *Selective Attention in Monkey Prefrontal Cortex.*

E

Ernst, M., Max-Planck-Institut für Biologische Kybernetik, Tübingen. (2002, November). *Combining Sensory Information From Sight and Touch.*

Esser, K.-H., Universität Ulm. (2002, July). *Rufen, Hören, Handeln – ein neuroethologischer Exkurs. [Calling, Hearing, Acting – A Neuro-Ethological Excursion].*

F

Falkenstein, M., Ifado, Leibniz-Institut für Arbeit und Arbeitsumwelt, Dortmund. (2002, April). *Event-Related Potentials After Response Errors.*

Fiedler, K., Universität Heidelberg. (2003, July). *Meta-Cognitive Myopia: Seeing the Data, but Missing the Story Behind.*

Fink, G., Institut für Medizin, Forschungszentrum Jülich. (2003, May). *Polymodal Processing in Human Parietal Cortex – Implications for Apraxia and Neglect.*

Franz, V., Justus-Liebig-Universität Gießen. (2003, July). *Current Theories on the Relationship of Perception and Action.*

G

Gegenfurtner, K., Justus-Liebig-Universität Gießen. (2003, May). *Farbe in Wahrnehmung und Handlung. [Color in Perception and Action].*

Giersch, A., INSERM; Hôpitaux Universitaires de Strasbourg, France. (2003, April). *Modulations in Visual Segmentation Processes: Attentional Influences?*

Glenberg, A. M., University of Wisconsin-Madison, USA. (2003, November). *Grounding Language Comprehension in Bodily Action.*

Goebel, R., University of Maastricht, NL (2003, January). *Mentale Chronometrie und gerichtete kortikale Interaktionen: Neue Erkenntnisse durch raumzeitlich hochaufgelöste fMRT Studien. [Mental Chronometry and Directed Cortical Interactions: New Insights Through Spatiotemporal High-Resolution fMRT Studies].*

Graf, M., Max-Planck-Institut für Biologische Kybernetik, Tübingen. (2002, April). *Topologische Transformationen bei der Kategorisierung von Objekten. [Topological Transformations in Object Categorization].*

Grawe, K., Universität Bern, Switzerland. (2002, January). *Konsistenztheorie: Grundlage für eine nicht an Therapieschulen orientierte Psychologische Therapie. [The Theory of Consistency: Foundation for a Psychological Therapy Not Based on Therapy Schools].*

Greenwald, A. G., University of Washington, USA. (2001, May). *The Resting Parrot, the Dessert Stomach, and Other Perfectly Defensible Theories.*

Greenwald, A. G., University of Washington, USA. (2001 May). *Validity of the Implicit Association Test.*

Greenwald, A. G., University of Washington, USA. (2002, October). *Better-Than-Perfect Timesharing When Simultaneous Tasks Are Ideomotor-Compatible.*

Grosjean, M., Pennsylvania State University, USA. (2001, May). *Temporal S-R Compatibility: Going Beyond Traditional Measures of Performance.*

Invited Lectures at the Institute

Güntürkün, O., Ruhr-Universität Bochum. (2002, January). *Die Gedächtnismaschine – neurale Grundlagen des Kurzzeitgedächtnisses. [The Memory Machine – The Neural Basis of Short-Term Memory].*

H

Haggard, P., University of London, UK (2003, June). *Body Representation by Touch and Vision.*

Hazeltine, E., NASA Ames Research Center, Moffet Field, USA. (2003, May). *Bimanual Cross-Talk During Reaching Movements: Evidence for Abstract Response Codes.*

Hoffmann, J., Universität Würzburg. (2002, April). *Consideration of the Ideo-Motor Principle.*

Huber, O., University of Fribourg, Switzerland. (2002, February). *Risikoentscheidungen – jenseits des Glücksspiel-Paradigmas. [Deciding Under Risk – Beyond the Gambling Paradigm].*

Humphreys, G. W., University of Birmingham, UK (2002, May). *The Interaction Between Doing and Seeing: Neuropsychological and Experimental Evidence.*

Hunnius, S., University of Groningen, NL (2003, July). *Die Entwicklung des Blickverhaltens in den ersten Lebensmonaten. [The Development of Gaze Behavior in Early Infancy].*

Hurley, S., University of Warwick, UK. (2003, February). *Why responsibility isn't essentially impossible.*

J

Jolicoeur, P., University of Waterloo, Canada. (2002, April). *Defining the Central Capacity Limitations of Human Information.*

Johnson, M. H., Birkbeck College, London, UK (2001, November). *Human Functional Brain Development: An Interactive Specialisation Approach.*

K

Karmiloff-Smith, A., Institute of Child Health, London, UK (2003, May). *Genotype/Phenotype Relations: A Cognitive Developmental Framework.*

Karnath, H.-O., Neurologische Klinik Tübingen. (2001, May). *Zur Wahrnehmung der Orientierung von Objekten und des eigenen Körpers. [On the Perception of the Orientation of Objects and One's Own Body].*

Kawato, M., ATR Computational Neuroscience Laboratories, Kyoto, Japan. (2002, July). *Computational Neuroscience of Internal Models.*

Kelemen, D., Boston University, USA. (2001, May). *Reasoning About Design and Object Function: The Development of Teleological Thought.*

Keller, P. H., New Haven, CT, USA. (2002, February). *Dual-Task Aspects of Musical Ensemble Performance.*

Kiefer, M., Universität Ulm. (2002, January). *Hirnelektrische Korrelate der Reaktionsinhibition. [Brain-Electrical Correlates in Response Inhibition].*

Klatzky, R., Carnegie-Mellon University, Pittsburgh, USA. (2003, December). *Spatial Navigation in the Absence of Vision.*

Klimesch, W., Universität Salzburg, Austria. (2003, November). *EEG-Oszillationen und individuelle Gedächtnisleistung. [EEG-Oscillations and Individual Memory Performance].*

Koch, C., Caltech, Pasadena, USA. (2002, December). *The Neuronal Correlates of Consciousness? Recording Single Neurons in the Human Medial Temporal Lobe?*

Koriat, A., University of Haifa, Israel. (2003, November). *Memory Organization of Action Events and Its Relationship to Memory Performance.*

Kourtzi, Z., Max-Planck-Institut für Biologische Kybernetik, Tübingen. (2001, June). *Shape Processing in the Human Brain.*

L

Lieberman, P., Brown University, Providence, USA. (2003, November). *On the Neural Bases of a "Universal Grammar" of Action, Language, and Cognition: The Role of the Basal Ganglia.*

M

MacNeilage, P. F. & Davis, B. L., University of Texas, Austin, USA. (2003, November). *The Hand and the Mouth in the Evolution of Language.*

Mele, A., Florida State University, USA. (2003, February). *Decisions, intentions, urges, and free will: Why Libet has not shown what he says he has.*

Metzinger, T., Universität Mainz. (2002, December). *Phenomenal Consciousness and the First-Person Perspective.*

Monsell, S., University of Exeter, UK (2002, November). *Task Switching: Where Are We Now?*

N

Nijhawan, R., University of Sussex, UK (2001, October). *Neural Transmission Delays, Visual Motion, and the Flash-Lag Effect.*

O

O'Regan, K., University of Boulogne, France. (2002, December). *Phenomenal Consciousness Explained (Better) in Terms of Bodiliness and Grabbiness.*

O'Regan, K., University of Boulogne, France. (2003, July). *Sensations as Intrinsic Laws of Sensorimotor Dependency: A Code-, Sensor-, and Effector-Independent Way for Biological and Artificial Organisms to Deduce Structure in the Environment.*

Owen, A., Medical Research Council, Cambridge, UK (2003, January). *The Role of the Lateral Frontal Cortex in Human Memory.*

P

Papousek, M., Kinderzentrum München. (2002, June). *Integration von Erfahrungen im frühen Säuglingsalter: Ergebnisse der Prager Lern-Experimente von Hanus Papousek. [Integrating Experience in Early Infancy: Results from Hanus Papousek's Prague Learning Experiments].*

Pauen, M., Otto von Guericke-Universität, Magdeburg. (2003, February). *Freedom and responsibility.*

Pauen, S., Universität Magdeburg. (2002, February). *Die Kategorisierung von Objekten im Kleinkindalter. [Infants' Object Categorization].*

Proctor, R. W., Purdue University, USA. (2002, July). *Relative Salience as a Determinant of Dimensional Prevalence in Two-Dimensional Spatial Compatibility Tasks.*

Proust, J., Institut Jean-Nicod (CNRS/EHESS), Paris, France. (2002, October). *Simulation and Mentalisation.*

Proust, J., Institut Jean-Nicod (CNRS/EHESS), Paris, France. (2003, February). *Can intentions be perceived?*

R

Repp, B. H., Haskins Laboratories, New Haven, USA. (2002, June). *Sensorimotor Synchronization With Auditory and Visual Sequences.*

Rizzolatti, G., University of Parma, Italy. (2003, November). *The Mirror-Neuron System and Language Evolution.*

Rochat, P., Emory University, Atlanta, USA. (2001, November). *Action Control and Developing Sense of Self in Infancy.*

Röder, B., Philipps-Universität Marburg. (2003, December). *Multisensorische Verarbeitung und cross-modale Kompensation bei blinden Menschen. [Multisensory Processing and Crossmodal Compensation in Blind Persons].*

Rosenbaum, D., Pennsylvania State University, USA. (2001, June). *Hand-Mind Coordination.*

Roth, G., Hanse-Wissenschaftskolleg, Delmenhorst. (2001, May). *Emotion und Kognition aus der Sicht der Hirnforschung. [Emotion and Cognition from a Neuroscience Perspective].*

Rovee-Collier, C., Rutgers University, New Brunswick, USA. (2001, November). *Infant Memory in Action.*

S

Sainburg, R. L., Pennsylvania State University, USA. (2003, May). *The Neural Foundations of Handedness: Evidence for Dynamic Dominance.*

Schack, T., Deutsche Sporthochschule Köln. (2001, December). *Zur kognitiven Architektur von Bewegungen. [On the Cognitive Architecture of Movements].*

Schöner, G., Ruhr-Universität Bochum. (2002, October). *Dynamic Field Theory of Embodied Cognition: A Developmental Perspective.*

Schröger, E., Universität Leipzig. (2003, April). *Readiness for and Shielding From Distraction as Two Opposing Functions of Working Memory.*

Schubotz, R., Max-Planck-Institut für Biologische Kybernetik, Tübingen. (2002, November). *Common Codes in the Brain? An fMRI-Based Approach.*

Shiffrar, M., Rutgers University, Newark, USA. (2002, January). *The Visual Perception of Object and Human Movement.*

Shiffrar, M., Rutgers University, Newark, USA. (2003, June). *Does Visual Experience Influence the Visual Analysis of Human Movement?*

Sodian, B., Universität Würzburg. (2001, May). *Verständnis intentionalen Handelns in der frühen Kindheit. [Infants' Understanding of Intentional Action].*

Sodian, B., Ludwig-Maximilians-Universität, München. (2002, December). *'Theory of Mind' im Säuglingsalter? [A 'Theory of Mind' in Infancy?].*

Spivey, M., Cornell University, Ithaca, USA. (2003, June). *On the Temporal Dynamics of Real-Time Cognition.*

Sternad, D., Pennsylvania State University, USA. (2003, August). *Rhythmic and Discrete Movements as Primitives for Complex Actions.*

Stoerig, P., Universität Düsseldorf. (2002, December). *Conscious Vision: the Other Side.*

Strack, F., Universität Würzburg. (2001, May). *Deliberative and Impulsive Determinants of Social Behavior.*

Strawson, G., University of Reading, UK. (2003, February). *Mental ballistics: The involuntariness of spontaneity.*

T

Tetens, H., Freie Universität Berlin. (2001, February). *Willensfreiheit und empirische Forschungsmethodik. [Free Will and Empirical Research Methodology].*

Theeuwes, J., Free University of Amsterdam, The Netherlands (2001, July). *Top-Down and Bottom-Up Control of Visual Selection.*

Tipper, S., University of Wales, Bangor, UK (2001, August). *Object and Location-Based Inhibition of Return (IOR):Implications for Memory and Attention.*

Tomasello, M., Max-Planck-Institut für Evolutionäre Anthropologie, Leipzig. (2003, January). *Intention-Reading and Imitative Learning in the Second Year of Life.*

Treue, S., Deutsches Primatenzentrum, Universität Göttingen. (2003, April). *The Influence of Attention on the Processing of Visual Motion Information.*

Turvey, M. T., University of Connecticut, USA. (2003, May). *Cognition and Coordination Dynamics.*

U

Ulrich, R., Universität Tübingen. (2003, December). *Der Abgleich von Geschwindigkeit und Genauigkeit: Chronopsychophysiologische Analysen. [Speed-Accuracy Trade-Off: Chronopsychophysiological Analyses].*

Umiltà, C., University of Padua, Italy. (2001, July). *Non-Spatial Attentional Shifts Between Modalities.*

Umiltà, C., University of Padua, Italy. (2003, March). *Is Access to Arithmetic Facts Automatic?*

V

Van Leeuwen, C., RIKEN Institute, Wako-Shi, Japan. (2002, December). *A "Complex-Systems" Approach to Perceptual Dynamics.*

Vogeley, K., Forschungszentrum Jülich. (2002, April). *Anticipation and Self-Consciousness.*

Von Hofsten, C., Uppsala University, Uppsala, Sweden (2001, November). *On the Early Development of Action, Perception, and Cognition.*

Vorberg, D., Technische Universität Braunschweig. (2003, June). *Steht unbewusste Informationsverarbeitung unter bewusster Kontrolle? Häufigkeits- und Sequenzeffekte bei maskiertem Priming. [Is Unconscious Information Processing Under Conscious Control? Frequency and Sequence Effects in Masked Priming].*

Vossenkuhl, W., Ludwig-Maximilians-Universität München. (2001, July). *Der eigene Wille. [One's Own Will].*

W

Ward, R., University of Wales, Bangor, UK (2001, January). *Contributions of the Pulvinar to Selective Attention and Response Control.*

Watson, G., University of California, Riverside, USA. (2003, February). *Will and will power.*

Watson, J., University of California at Berkeley, USA. (2001, May). *'Intention Contagion' in Cognitive Development: A Speculation From Research on Infants, Rett Syndrome, and Artificial Life.*

Wegner, D., Harvard University, Cambridge, USA (2001, May). *What Good is an Epiphenomenon? Why Conscious Will Might Be Useful.*

Wexler, M., CNRS Paris, France. (2001, November). *Self-Motion and Spatial Vision.*

Wiesendanger, M., Universität Bern, Switzerland. (2003, May). *Bimanual Coordination in Simple and Highly Skilled Tasks.*

Wolpert, D., University College London, UK (2002, April). *Forward Models in Sensorimotor Control.*

Z

Zimmer, A., Universität Regensburg. (2001, December). *Opportunistisches Planen. [Opportunistic Planning].*

Projects Supported by Third-Party Funds[1]

Gisa Aschersleben, Annette Hohenberger, Annette Karmiloff-Smith (Institute of Child Health, University College London, UK), and Scania de Schonen (CNRS, Paris, France).

Effects of Attachment on Early Cognitive Development. Pampers European Research Consortium.

Funded by Procter & Gamble (1.6.2003 – 28.2.2005).

The project investigates the effects of attachment on the development of three cognitive areas at 6 and 10 months: speech perception, face processing and action perception.

Gisa Aschersleben, Wolfgang Prinz, Franz Mechsner, Prisca Stenneken, and Bernhard Hommel (Leiden University, NL)

Die Integration von sensorischem Feedback und motorischen Kontrollstrukturen. [The Integration of Sensory Feedback and Motor Control Structures].

DFG project C2 within the Special Research Unit 462 *Sensomotorik: Analyse biologischer Systeme, Modellierung und medizinisch-technische Nutzung. [Sensorimotor Functions: Analysis, Modeling and Medical-Technical Application of Biological Systems].* (1st phase: 1.7.1996 – 30.6.1999, 2nd phase: 1.7.1999 – 31.12.2002, 3rd phase: 1.1.2003 – 31.12.2003).

See Sections 2.1, 2.2, and 5.1.

Gisa Aschersleben, Jochen Müsseler, and Sonja Stork

Aufgabenabhängige Datierung von Wahrnehmungsereignissen. [Task-Dependent Timing of Perceptual Events].

DFG project AS 79/3 (1st phase: 1.10.2000 – 31.9.2002, 2nd phase: 15.11.2003 – 14.11.2005).

See Section 1.1 and 1.3.

Thomas Goschke

Modularität und Integration beim impliziten Lernen sequentieller Strukturen. [Modularity and Integration in Implicit Learning of Sequential Structures].

DFG project GO 720/1-2 (1999 – 2001).

See Section 5.3.

Thomas Goschke, Oliver Gruber (Universität des Saarlandes, Homburg, and Max Planck Institute of Cognitive Neuroscience, Leipzig)

Dynamic Interactions Between Complementary Components of Executive Control: Combination of Behavioral Experiments and Functional Neuroimaging.

DFG project GO 720/3-1 within the Priority Program SPP 1107 *Executive Functions* (2001 – 2003).

See Sections 4.1, 4.2.

Thomas Goschke, Paul F. Verschure (Institut für Neuroinformatik, ETH Zürich, Switzerland), and Claus R. Rollinger (Cognitive Science Programme, Universität Osnabrück)

Comparative Cognitive Robotics: Towards an Integrative Model of Learning and Adaptation in Autonomous Agents.

Funded by VolkswagenStiftung (2000 – 2003).

We study learning of sensory and behavioral patterns in humans and robots in an attempt to develop an integrative model of basic forms of learning and adaptation in autonomous agents. Specifically, results from experimental studies of implicit learning of event and action sequences in humans are used to constrain and validate neural network models of sequence learning developed within the "Distributed Adaptive Control" (DAC) framework developed by Verschure and his group.

Dirk Kerzel, Nathalie Ziegler (Universität Giessen)

Interaktionen zwischen Aufmerksamkeit, der Steuerung glatter Augefolgebewegungen und Lokalisationsurteilen. [Interactions Between Attention, Control of Smooth Pursuit Eye Movements, and Object Localization].

DFG project KE 825/4-1,2 (1.8.2002 – 31.7.2005).

The control of smooth pursuit eye movements (SPEM) has been modeled as a closed loop system. In research on SPEM, there is some, albeit sparse, evidence for a linkage between the execution of eye movements and attention. We aim at providing further, more convincing evidence for coupling of attention and SPEM.

[1] *In the following: DFG = Deutsche Forschungsgemeinschaft (German Science Foundation).*

Günther Knoblich, Michael Öllinger

Einsicht beim Problemlösen. [Insight in Problem Solving].

DFG project KN 489/6-1 (1.1.2002 – 31.1.2004).

This project examines the cognitive processes which underlie insight in problem solving and related phenomena.

Iring Koch

Response Selection Account of Task-Set Shifting.

DFG project KO 2045/4-1 within the Priority Program SPP 1107 *Executive Functions* (1.11.2001 – 1.11.2003).

See Section 4.2.

Iring Koch, Wolfgang Prinz, Nachshon Meiran (University of Beer Sheva, Israel), Yves von Cramon, and Marcel Braß (MPI of Cognitive Neuroscience, Leipzig).

Neurocognitive Analysis of Executive Functions in Task Switching.

German-Israeli Foundation for Scientific Research and Development (GIF), grant No. 635-88.4/1999 (until 31.12.2003).

See Section 4.2.

Ralf Möller, Andreas Engel (Institute of Neurophysiology and Pathophysiology, Universitätsklinikum Hamburg-Eppendorf), Rolf Pfeifer (Department of Information Technology, Universität Zürich), Peter König (ETH/Universität Zürich, Switzerland), and Matthew Diamond (Scuola Internazionale Superiore di Studi Avanzati, SISSA, Trieste, Italy)

Artificial Mouse (AMOUSE).

Funded by the European Community, Project No. IST-2000-28127 (Start: October 2001, duration 4 years).

See Research Unit 3.

Jochen Müsseler, Peter Wühr

Interferences Between Action Control and Perceptual Processes.

DFG project MU 1298/2 (until 30.9.2001).

See Sections 3.1 and 3.2.

Gertrud Nunner-Winkler, Marion Nikele, and Doris Wohlrab

Anerkennung moralischer Normen. [Recognition of Moral Norms]. Part of the compound of 17 research projects *Promoting Social Integration in Modern Societies.*

Financed by the Bundesministerium für Bildung und Forschung [German Ministry of Education and Research], grant 624-40007-07 SWF 99A, 1.6.2002 – 31.5.2005.

See Research Unit 5.

Wolfgang Prinz, Gisa Aschersleben, Katharina Müller, Bettina Pollok, and H.-J. Freund, Alfons Schnitzler, Frank Schmitz (all Dept. of Neurology, Heinrich-Heine-Universität, Düsseldorf)

Handlungskontrolle: Funktionsanalyse und Pathologie. [Action Control: Functional Analysis and Pathology].

Special grant from the Max Planck Society (PSF0320, 15.4.1997 – 31.12.2002).

See Section 2.1.

Wolfgang Prinz, Sabine Maasen, Thomas Goschke, Thomas Splett, Tillmann Vierkant, Bettina Walde, and Wilhelm Vossenkuhl (Ludwig-Maximilians-Universität München)

Voluntary Action: Investigations into the Nature and Culture of Volition.

Interdisciplinary Research Project funded by VolkswagenStiftung 1.1.2001 – 31.12.2004.

See Section 4.6.

Edmund Wascher

Investigation of the Functional Distinctiveness of Event-Related Lateralizations of the EEG as a Tool to Explore Visuomotor Interactions.

DFG project WA 987/7-1 within the Priority Program *Sensorimotor Integration* (1998 – 2002).

See Research Unit 2.

Edmund Wascher, Monika Kiss

EEG-Correlates of Visual Search: Investigation of Discriminative Subprocesses in Visual Perception.

DFG project WA 987/6-1/3 (1999 – 2004).

See Research Unit 2.

Cooperations

Allport, Alan (St. Anne's College, Oxford University, UK) with Iring Koch, Wolfgang Prinz.

Item-Priming Effects in Task-Switching.

See Section 4.3.

Allport, Alan (St. Anne's College, Oxford University, UK) with Florian Waszak.

Item-Specific Transfer in Task-Switching: Role of Episodic S-R Bindings in Switch Costs.

See Section 4.3.

Avikainen, Sari; Liuhanen, Sasu; Hari, Riitta (all Brain Research Unit, Helsinki University of Technology, Finland); Hänninen, Ritva (Central Hospital of Central Finland) with Andreas Wohlschläger.

Imitation in Adult Autistics.

See Section 2.4.

Bachmann, Talis (University of Tartu, Tallin, Estonia) with Gisa Aschersleben.

Metacontrast and Synchronization.

See Section 1.3.

Baillargeon, Renée (Dept. of Psychology, University of Illinois, Urbana-Champaign, USA) with Petra Hauf.

Weight Perception and Reaching Behavior in Infants.

Several of our studies investigate how the haptically perceived weight of an object influences infants' reaching behavior and how this is connected to different variables like size, material, and compression. In a series of experiments we elaborate on whether infants transfer their knowledge about the weight of an object to similar situations. Further, we ask whether infants are able to infer weight from visual information although no prior haptical experience was given.

Baltes, Paul; Li, Shu-Chen; Lindenberger, Ulman (all Max Planck Institute for Human Development, Berlin); Schneider, Werner X. (Ludwig-Maximilians-Universität München) with Gisa Aschersleben, Knut Drewing, Bernhard Hommel (Leiden University, NL), and Wolfgang Prinz.

Peripheral and Central Factors of Cognitive Aging.

Findings by Baltes and co-workers have revealed close relations between sensory and intellectual abilities, particularly in older persons. These could be due to age-related changes in the proportion of cognitive resources taken up by simple sensory and sensorimotor functions. To analyze the functional basis of these relationships, we ran a cross-sectional study with participants aged 6 to 89 years. It included a large number of measures of sensory and intellectual abilities and eight pairs of cognitive tasks differing systematically in terms of their demands on cognitive resources. Results agree with earlier studies indicating that the differences between tasks of varying complexity are much more marked in the young and the aged compared with the middle-aged.

Bäuml, Karl-Heinz; Bauer, Stefanie (Dept. of Psychology, Universität Regensburg) with Petra Hauf, Gisa Aschersleben.

Retroactive Interferences in 18-Month-Old Infants.

See Research Unit 1.

Bertelson, Paul (Free University of Brussels, Belgium) with Gisa Aschersleben.

Crossmodal Interaction in the Perceived Timing of Events.

See Section 1.4.

Boecker, Henning (NEUROcenter Functional Imaging, Technische Universität München, Klinikum rechts der Isar) with Edmund Wascher.

Physiological Correlates of Relations Between Perception and Action – an Event-Related fMRI Study on Spatial S-R Correspondence.

The contribution of dorsal and ventral processes to different types of spatial S-R correspondence will be tested in an imaging study.

Bülthoff, Heinrich H. (Max Planck Institute for Biological Cybernetics, Tübingen); Franz, Volker (Justus-Liebig-Universität Giessen) with Edmund Wascher.

EEG-Correlates of the Plasticity of Human Visuomotor Coordination.

To perform goal-directed hand movements we need to integrate visual and proprioceptive information. If the visual feedback is manipulated these computations will be disturbed. Plasticity of the human visuomotor system is demonstrated by gradually decreasing errors until stable aiming accuracy is re-established and by a negative after-effect when the prisms are removed. We implement EEG recordings to study the effect of manipulated visual feedback on cortical activity during pointing movements.

Cole, Jonathan (University of Southampton, UK) with Gisa Aschersleben, Knut Drewing, Prisca Stenneken, and Wolfgang Prinz.

Sensory Feedback and the Timing of Actions: Studies with the Deafferented Patient I. W.

See Section 2.1.

Danek, Adrian (Ludwig-Maximilians-Universität München) with Franz Mechsner, Wolfgang Prinz, and Matthias Weigelt.

Bimanual Coordination in Mirror-Symmetry patients.

The aim of this study is to investigate bimanual coordination in patients who suffer from mirror symmetry. This patient population displays a neurological disorder that leads to the constant co-activation of homologous muscles in the contralateral upper limb when only a single limb movement is intended. We ask whether these patients can overcome mirror symmetry for goal-directed behavior in two situations: First, when continuous bimanual movements of nonhomologous muscles produce a perceptually symmetrical pattern and, second, discrete bimanual movements of nonhomologous muscles are directed to perceptually similar targets.

De Schonen, Scania (CNRS, Paris, France) with Gisa Aschersleben, Annette Hohenberger.

Effects of Attachment on Early Cognitive Development.

See also Appendix (Projects Supported by Third-Party Funds).

Freund, Hans-Joachim; Schnitzler, Alfons; Schmitz, Frank (all Dept. for Neurology, Heinrich-Heine-Universität Düsseldorf) with Gisa Aschersleben, Katharina Müller, Wolfgang Prinz, and Bettina Pollok.

Action Control: Functional Analysis with Neuroimaging Techniques.

See Section 2.1.

Friederici, Angela D.; Gunter, Thomas (Max Planck Institute of Cognitive Neuroscience, Leipzig) with Patric Bach, Günther Knoblich, and Wolfgang Prinz.

Action Comprehension.

Studies the cognitive and neural processes that contribute to forming an integrated representation of observed action sequences.

Frith, Chris (University College, London, UK) with Natalie Sebanz, Günther Knoblich, and Wolfgang Prinz.

fMRI Studies of Joint Action.

See Section 2.5.

Gattis, Merideth (School of Psychology, Cardiff University, UK); Bekkering, Harold (University of Nijmegen, NL) with Andreas Wohlschläger.

Imitation in Preschoolers.

See Section 2.4.

Gauggel, Siegfried (Technische Universität Chemnitz) with Martina Rieger.

Neuropsychology of Action Inhibition.

Studies with neurological patients are conducted to investigate neuroanatomical correlates of the inhibition of ongoing actions.

Gergely, György; Király, Ildikó (Hungarian Academy of Sciences, Budapest) with Harold Bekkering (University of Nijmegen, NL).

Rational Imitation of Goal-Directed Actions in 14-Month-Olds.

See Section 2.4.

Gergely, György; Király, Ildikó (Hungarian Academy of Sciences, Budapest) with Gisa Aschersleben, Bianca Jovanovic, and Wolfgang Prinz.

Early Development of Action Perception.

See Research Unit 1.

Gorea, Andrei (Laboratoire de Psychologie Expérimentale, CNRS & Université René Descartes, Paris, France) with Florian Waszak.

Interaction of Perceptual and Motor Processes.

It is commonly accepted that the effect of a visual stimulus on the motor system is to some degree independent of its effect on the perceptual system (similar to "subliminal perception"). However, little is known about the concrete mechanisms that control the processing of information in the two systems – the sensory-perceptual system controlling the perceptual analysis of the signal and the sensorimotor system controlling the translation of the visual information into the motor system. The project will show that the two systems operate in a different way in that the former can be described as a decisional system, whereas the later constitutes a reflexive system.

Greenwald, Anthony (University of Washington, Seattle, USA) with Edmund Wascher, Jochen Müsseler.

Mechanisms Involved in Subliminal Priming.

See Research Unit 2.

Gruber, Oliver (Max Planck Institute of Cognitive Neuroscience, Leipzig) with Thomas Goschke.

Dynamic Interactions Between Complementary Components of Executive Control: Combination of Behavioral Experiments and Functional Neuroimaging.

See Sections 4.1, 4.2.

Cooperations

Haggard, Patrick (University College London, UK) with Andreas Wohlschläger, Kai Engbert, and Wolfgang Prinz.

Awareness of Self-and Other-Generated Actions.

See Section 1.5.

Haggard, Patrick (University College London, UK) with Gisa Aschersleben, Wolfgang Prinz.

Binding in Perceived Timing of Stimuli and of Actions.

See Section 1.4.

Haggard, Patrick (University College London, UK) with Rüdiger Flach, Wolfgang Prinz.

Spatio-Temporal Interactions in Touch.

Many perceptual illusions give evidence for an intimate link between space and time. Here, we are taking a closer look at one of these illusions, which has become to be known as the "cutaneous rabbit" effect. In particular, we suggest a model that capitalizes on the ideas of spatial summation and temporal decay. Thus, we show that the assumption of an (on the average) veridical location of individual taps can be retained when the illusory location of multiple taps should be explained. In further experiments, we showed that the perceptual illusion in question cannot be traced back to an interaction of perceived time and space. Finally, we addressed the role of spatial attention in the "cutaneous rabbit" effect. Results suggest that attentional effects can be found, although they seem not to interact with the effect of the ISI variable, which constitutes the proper tactile spatio-temporal illusion.

Hany, Ernst A. (Universität Erfurt) with Ulrich Geppert.

As a former senior researcher of Franz Weinert's department he is in charge of the theme

Elementary Cognitive Processes and Psychometric Intelligence.

See Research Unit 6.

Heijden, A. H. C. van der (Leiden University, NL) with Jochen Müsseler.

Localizing Briefly Presented Stimuli.

See Section 1.1.

Hoole, Philip (Phonetics Dept., Ludwig-Maximilians-Universität München); Honda, Kiyoshi (Advanced Telecommunications Research Institute, Japan) with Rafael Laboissière.

EMG and Kinematic Studies in Speech Production.

See Research Unit 4.

Iacoboni, Marco; Koski, Lisa; Woods, Roger P.; Dubeau, Marie-Charlotte; Mazziotta, John C. (all University of California, Los Angeles, USA); Bekkering, Harold (University of Nijmegen, NL) with Andreas Wohlschläger.

Modulation of Motor and Premotor Activity During Imitation of Target-Directed Actions.

See Section 2.4.

Jolicoeur, Pierre (Université de Montréal, Canada) with Iring Koch.

Orthogonal Cross-Talk Compatibility.

See Section 3.2.

Jordan, Jerome Scott (Illinois State University, USA) with Günther Knoblich.

Joint Action.

See Section 2.5.

Jordan, Jerome Scott (Illinois State University, USA) with Jochen Müsseler, Dirk Kerzel, Lothar Knuf, and Sonja Stork.

Effects of Intention on Perception.

See Section 1.2.

Jordan, Jerome Scott (Dept. of Psychology, Illinois State University, USA) with Franz Mechsner.

Visual Control of Movement Coordination in Humans.

We investigate visual control of movement coordination. The idea is to dissociate visual effects from hand movements on as many dimensions as possible and to see how control of the effects is influenced by these manipulations.

Karmiloff-Smith, Annette (University College London, UK) with Gisa Aschersleben, Annette Hohenberger.

Effects of Attachment on Early Cognitive Development.

See Appendix (Projects Supported by Third-Party Funds).

Kawato, Mitsuo (ATR Computational Neuroscience Laboratories, Kyoto, Japan) with Rafael Laboissiere.

Experimental Techniques for the Measurement of the Equilibrium Point Trajectories in Human Arm Movements.

See Research Unit 4.

Kircher, Tilo; Leube, Dirk; Stottmeister, Frank (all Universität Tübingen) with Günther Knoblich.

Perception of Self and Other.

See Section 1.5.

Könies, Axel (Max Planck Institute of Plasma Physics, Greifswald), with Ralf Möller.

Coupled Principal Component Analysis.

See Research Unit 3.

Koriat, Asher (University of Haifa, Israel) with Jochen Müsseler, Monika Nißlein.

Structural Sentence Processing and Letter Detection.

This project examined early structural processes during reading. A robust finding in this area is the so-called missing-letter effect, MLE. When asked to circle a target letter in connected text, participants are more likely to miss that letter in frequent function words (determiners etc.) than in less common content words (e.g., nouns, verbs). We exploited some of the unique properties of German to clarify this effect.

Koski, Lisa; Woods, Roger P.; Dubeau, Marie-Charlotte; Mazziotta, John C.; Iacoboni, Marco (all UCLA School of Medicine, USA); Bekkering, Harold (University of Nijmegen, NL) with Andreas Wohlschläger.

An fMRI Study of Goal-Directed Imitation.

See Section 2.4.

Kunde, Wilfried (Martin-Luther-Universität Halle) with Iring Koch.

Response-Effect Compatibility.

See Section 5.2.

Luo, Zhi-wei (Riken Institute and the Faculty of Engineering, Nagoya University, Japan) with Ken Ohta, Rafael Laboissière.

Optimal Trajectories in Constrained Movements.

See Research Unit 4.

Meiran, Nachshon (University of Beer Sheva, Israel); von Cramon, Yves; Braß, Marcel (Max Planck Institute of Cognitive Neuroscience, Leipzig) with Iring Koch, Wolfgang Prinz (counseled by Bernhard Hommel, Leiden University, NL).

Neurocognitive Analysis of Executive Functions in Task Switching.

See Section 4.2, and Appendix (Projects Supported by Third-Party Funds).

Metzinger, Thomas (Johannes Gutenberg-Universität Mainz) with Günther Knoblich, Birgit Elsner, and Gisa Aschersleben.

Self and Action.

Theoretical integration of different branches of research on Self and Action.

Meyer, Thomas D. (Universität Tübingen) with Edmund Wascher.

Psychophysiological Investigations on the Risk for Bipolar Affective Disorders.

We investigate the theory of a fundamental dysfunction in the behavior-activation system in persons hypothesized to be at risk for Bipolar Affective Disorders. To this end we measure ERP correlates of cognitive processing in tasks in which the control of movement activation is essential to perform properly. Participants are young adults at risk for affective disorders as measured by the Hypomanic Personality Scale.

Moore, Cathleen M. (Pennsylvania State University, PA, USA); Lleras, Alejandro (University of British Columbia, Canada); Marrara, Mark (Metavente Corporation, USA) with Marc Grosjean.

Using Inattentional Blindness as an Operational Definition of Unattended.

The aim of this project is to use *inattentional blindness* – the lack of awareness of salient but unexpected stimuli appearing in unattended regions of the visual field – to explore what forms of perceptual and motor processes can be engaged without attention.

Mordkoff, J. Toby (Pennsylvania State University, PA, USA) with Marc Grosjean.

The Influence of Action Preparation on Object Recognition.

There is an existing conflict concerning how preparing an action is thought to specifically influence the ability to recognize objects that share features with that action. In the present project, we attempt to resolve this conflict by combining the experimental conditions used until now (e.g., speeded and masked-accuracy conditions) within the same task in order to establish that existing patterns of results can actually be attributed to the operation of different sets of processes.

Neggers, Sebastiaan (University of Utrecht, NL) with Jochen Müsseler, Sonja Stork.

Smooth Pursuit Eye Movements.

See Section 1.2.

Neyer, Franz J. (Humboldt-Universität Berlin) with Ulrich Geppert.

As a former member of Franz Weinert's research department Franz Neyer is in charge of the theme

Twin Relationships in Adulthood.

See Research Unit 6.

Cooperations

Ohlsson, Stellan; Raney, Gary (University of Illinois at Chicago, USA) with Günther Knoblich.

Insight Problem Solving.

Insight problem solving is characterized by impasses, states of mind, in which the thinker does not know what to do next. We study how such impasses arise and how they are resolved. The results of several experiments suggest that prior knowledge can bias the initial problem representation in a way that keeps the problem solver from finding the solution. This bias may be reversed by implicit processes that change the representation of the problem elements or the goal. The reversal suddenly allows the problem solver to see the solution, at least if it is simple.

O'Regan, J. Kevin (Institut de Psychologie, Centre Universitaire de Boulogne, Paris, France) with Edmund Wascher.

ERP Correlates of Aware Stimulus Processing.

See Research Unit 2.

Ostry, David (Dept. of Psychology, McGill University, Montreal, Canada) with Rafael Laboissière.

Sensorimotor Control of Human Jaw Movement. Project Start: April 2002, End: March 2007.

See Research Unit 4.

Paillard, Jacques (CNRS, Marseille, France) with Gisa Aschersleben, Prisca Stenneken, and Wolfgang Prinz.

Sensory Feedback and the Timing of Actions: Studies with the Deafferented Patient G. L.

See Section 2.1.

Proust, Joelle (Institute Jean Nicod, CNRS, Paris, France) with Günther Knoblich, Wolfgang Prinz.

Action Simulation.

Theoretical and empirical investigations addressing motor contributions to action perception, action prediction, and the understanding of others' mental states.

Repp, Bruno H. (Haskins Laboratories, USA) with Peter Keller.

Sensorimotor Syncopation.

Humans are often required to produce movements so as to bisect the time intervals between regularly occurring events, e.g., a musician playing the 'pahs' in an Oom-pah band, or a listener – with beer in hand – attempting to tap his or her foot with the 'pahs' rather than with the 'ooms'. Most people find that it is difficult to maintain this form of syncopation and consequently end up moving in synchrony, i.e., simultaneously, with the regular events (the 'ooms'). This project uses a basic task – wherein participants are instructed to make finger taps (without the beer) at the midpoint between the tones of metronomic auditory sequences – to investigate techniques for making sensorimotor syncopation easier. The techniques examined include using different hand assignments (e.g., one versus two alternating hands) and mentally grouping tones and taps in accordance with musical metric schemes (e.g., cycles of two, three, or four beats). Results indicate that sensorimotor syncopation is much easier with one hand than with two alternating hands and that mental grouping strategies facilitate performance.

Repp, Bruno (Haskins Laboratories, New Haven, CN, USA) with Günther Knoblich.

Perception of Self and Other.

See Section 1.5.

Rosenbaum, David (Pennsylvania State University, Pennsylvania, USA) with Florian Waszak, Peter Keller, Edmund Wascher, Gisa Aschersleben, Iring Koch, and Wolfgang Prinz.

Intentional and Reactive Components of Action Control.

See Section 4.5.

Rumiati, Raffaella (Scuola Internazionale Superiore di Studi Avanzati, Trieste, Italy) with Iring Koch.

Action Priming in Dual Tasks.

See Section 3.2.

Rumiati, Raffaella (Scuola Internazionale Superiore di Studi Avanzati, Trieste, Italy) with Iring Koch.

Sequence Learning in Frontal Patients.

The aim of this study is to test the idea that motor-sequence learning requires the formation of complex action plans (response chunks or motor programs), so that frontal patients should be impaired although they do not have specific motor deficits but only planning deficits.

Sarris, Viktor (Institute for Psychology, Johann Wolfgang Goethe-Universität Frankfurt/M.) with Petra Hauf.

Multidimensional Psychophysics in Humans and Animals.

Several studies investigated context effects on choice behavior during color and size discrimination in humans as well as in chickens. Different training conditions were used to establish the frame-of-reference for post-training generalization testing. The findings reveal not only dimension-specific shifts in choice behavior but also different amounts of absolute resp. relative encoding depending on the training condition used. Furthermore, we investigated context-dependent stimulus coding in humans and chickens for the ecologically important, but largely neglected, two-dimensional case. Different testing procedures demonstrated profound context effects in both species. They differed, however, in the way information from either dimension was used. Results show a higher flexibility of encoding and generalization in humans as well as differing principles of information integration in the two species.

Sarris, Viktor; Kleppe, Monika (Institute for Psychology, Johann Wolfgang Goethe-Universität Frankfurt/M.) with Petra Hauf, Gisa Aschersleben.

Influence of Haptic Experience on Visual Perception of Physical Events.

See Research Unit 1.

Schack, Thomas (Deutsche Sporthochschule Köln) with Franz Mechsner.

Antizipative Steuerung komplexer sportlicher Bewegungen. [Anticipating the Control of Complex Movements in Sports].

The hypothesis of anticipatory perceptual control is explored in complex movements such as the tennis serve. There seem to be mental representations in experts that are well suited for solving the functional problems in connection with complex movements.

Scheucher, Birgit (Verkehrspsychologische Praxis München) with Gisa Aschersleben.

The Impact of a Short-Term Driver Improvement Course for Alcohol Impaired Drivers.

The project examines the long-term effects of a driver improvement course. Five years after the course the former participants answered a questionnaire about their current coping with alcohol and their drinking and driving behavior. Results showed that the drinking behavior of the large majority had been stable as compared to their former decisions, that is they were still totally abstinent or controlled their drinking behavior corresponding to their commitment.

Seitz, Rüdiger (Neurologische Klinik, Heinrich-Heine-Universität Düsseldorf) with Katharina Müller, Franz Mechsner.

Hirnaktivität bei räumlich und muskulär definierter bimanueller Koordination. [Brain Activity in Spatially and Muscular Defined Bimanual Coordination].

For bimanual finger oscillation, we try to dissociate brain activity connected with muscular symmetry from activity connected with perceptual symmetry.

Shiffrar, Maggie (Rutgers University, NJ, USA); Thornton, Ian (Max Planck Institute for Biological Cybernetics, Tübingen) with Marc Grosjean, Günther Knoblich.

Body Perception and Action Perception.

Theoretical and empirical investigations addressing body perception and action perception.

Shiffrar, Maggie (Rutgers University, NJ, USA) with Marc Grosjean, Günther Knoblich.

Perceiving Speed-Accuracy Tradeoffs in Action Control.

This project attempts to determine whether and how the motor processes responsible for speed-accuracy tradeoffs in action control (e.g., as captured by Fitts' law) play a role in the perception of others' actions.

Siebner, Hartwig R.; Conrad, Bastian (Neurologische Klinik des Klinikums rechts der Isar, Technische Universität München) with Birgit Elsner (now Universität Heidelberg), Bernhard Hommel (Leiden University, NL), and Wolfgang Prinz.

Die Verknüpfung von Handlungen und ihren Konsequenzen im menschlichen Gehirn [Linking Actions and their Perceivable Consequences in the Human Brain].

See Section 5.1.

Stumpf, Luitgard (Integrationszentrum für Menschen mit Autismus/MAut, München) with Natalie Sebanz, Günther Knoblich, and Wolfgang Prinz.

Joint Action in Autistic Individuals.

See Section 2.5.

Tipper, Steve (University of Bangor, Wales, UK) with Edmund Wascher.

EEG-Correlates of Object- and Space-Based Inhibition-of-Return (IOR).

See Research Unit 2.

Cooperations

Vogeley, Kai (Universität Bonn); Ritzl, Afra; Schilbach, Leonhard; Fink, Gereon R.; Zilles, Karl (all Research Center Jülich) with Andreas Wohlschläger.

Neural Correlates of Top-Down Influences on Apparent Motion Perception.

Intention-Dependent Perception of the Direction of Ambiguous Apparent Motion. This fMRI study in healthy subjects, shows a strong involvement of left parietal areas in action-dependent apparent motion perception. The left parietal lobe is thought to mediate between perception and action by receiving both, perceptual input and an efference copy of the hand movement. In addition, pilot studies in apractic patients show that an intact left parietal lobe seems to be a prerequisite for this type of action perception interaction.

Wühr, Peter (Friedrich-Alexander-Universität Erlangen-Nürnberg) with Florian Waszak.

Interaction of Object-Based and Space-Based Attention in the Stroop Task.

The Stroop effect is the inability to ignore the meaning of a color word (i.e. the word "red"), when the task is to name the ink color of that word. This effect is usually ascribed to a failure in the spatial selectivity of attention, i.e. the inability to ignore irrelevant information at an attended location. Our study investigated whether object-based processing contributes to the Stroop effect. According to this view, observers are unable to ignore irrelevant features of an attended object. In three experiments, participants had to name the color of one of two superimposed rectangles, and to ignore words that appeared either in the relevant object, in the irrelevant object, or in the background. The words were congruent, neutral, or incongruent with respect to the correct response. Incongruent words in the irrelevant object and in the background produced significant Stroop interference, suggesting a lack of spatial selectivity. However, incongruent words in the relevant object produced significantly more interference than the other conditions, suggesting facilitation in the processing of all the features of an attended object. Thus, object-based processing seems to be involved in the Stroop effect.

A collaboration of the Max Planck Institute of Cognitive Neuroscience and the Max Planck Institute für Psychological Research on

Action Planning and Action Perception

For a couple of years there has been an overlap in the research interests of the MPI of Cognitive Neuroscience in Leipzig and the MPI for Psychological Research in Munich. Both institutes aimed at the cognitive processes underlying action planning, action coordination, and action perception of self- and other-generated actions. The MPI in Leipzig seeks to explain the links between mental functions and related cerebral regions, the MPI in Munich aimed at the functional architecture of these processes. To attain synergetic collaborations between institutes, four projects were established supported by a grant of the Max Planck Society.

Executive Control and Perceptual Processin

Stefan Zysset (Leipzig), Jochen Müsseler (Munich), Claudia Danielmeier (PhD student, Leipzig). See Sections 3.1 and 3.2.

Action Comprehension

Günther Knoblich (Munich), Thomas Gunter (Leipzig), Patric Bach (PhD student, Munich). This project addresses the processes involved in action comprehension. In particular, we assume that spatial and functional relations between effector, instruments, and objects are processed in parallel and are later integrated to form representation of actions and action sequences. The results of behavioral and ERP experiments provide ample support for this claim.

Endogenous Processes During Task Shifting

Marcel Braß (Leipzig), Iring Koch (Munich), Birte Forstmann (PhD student, Leipzig). See Section 4.1.

Effect-Related Action Planning in Musicians

Martina Rieger (Munich), Marcel Braß (Leipzig), Thomas Gunter (Leipzig), Ulrich Christian Drost (PhD student, Munich). See Section 5.4.

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Scientific Information

Library

Primarily, the library is a research service that focuses on collecting literature on the specific research areas of the Institute. However, from the very beginning, its task has also been to include basic literature for the entire field of scientific psychology. With a continuous growth in stock and a careful acquisition strategy (including the purchase of used books), the library has now evolved from a narrowly focused research resource into a respectable collection covering the broad field of academic psychology. The collection to date consists of about 43.000 monographs and 16.000 bound journals. There are approximately 340 journal subscriptions. In addition, the library holds a compendium of psychological tests (Testothek) and the private library inherited from the late Prof. Dr. Kurt Gottschaldt.

The cataloguing and shelving systems are organized according to a somewhat modified version of the classification system of the American Psychological Association (APA). All titles are multiply classified according to this system. We employ the software system *Aleph*, which not only allows the automation of most library work flow but also provides a Web Online Catalogue, a powerful scientific research tool. The installation of *Aleph* on a central server at the *Gesellschaft für wissenschaftliche Datenverarbeitung* in Göttingen (GWDG) is a joint project of about 30 Max Planck Institutes who have access to the system via the internet.

Frank Halisch
(head)

Documentation and Information

Wide-ranging electronic facilities are available for documentation and information. Online information services are provided by the Max Planck Society on a central server of the GWDG as well as on the basis of the institute's own license contracts with several publishers. These enable institute members' online access to (1) various literature databases, in particular *PsycInfo, PsyndexPlus, e-psyche, Current Contents, Medline,* etc., (2) the *Web of Knowledge* - consisting of the *Web of Science,* the most comprehensive scientific literature database in the world, as well as the *Journal Citation Report* for ascertaining journal impact factors, and (3) numerous journals offering access to electronic full-text articles. Within the next years, those services will be continuously extended by the Max Planck Society's increasing efforts to implement modern information-management services for the Max Planck institutes.

Press and Public Relations

Recent years have experienced an upsurge of the media's interest in scientific topics. As a non-profit organization funded by federal and state subsidies, the Max Planck Society values intensive public relations (PR) and endorses making the individual institutes' research work accessible to the general public.

The PR office promotes coverage of our institute's research work, and it coordinates and documents all PR activities. It responds to general and media inquiries, either directly or by mediating to inhouse experts, as well as regularly informs the regional and national print media, radio and TV stations, by issuing press releases, etc. Close cooperation exists with the Press Office of the Max Planck Society's Headquarters, chiefly about publishing reports on our work in the MPG-edited journals 'MaxPlanckForschung' and 'MaxPlanckResearch'.

Interviews and articles on our research activities have been published by national papers and journals as, for example, Süddeutsche Zeitung, Spiegel, and GEO. Examples for broadcastings on radio and TV are two contributions to 'Telekolleg', an educational program of the Bayerischer Rundfunk, as well as a report on our research unit 'Infant Cognition and Action', which was produced within a cooperation between the Max Planck Society and 3sat for a science program ('nano'). All PR activities are documented in a press review, and in an appropriate (i.e., technical) archive.

Monika Nißlein
(Research Coordinator)

Scientific Information, Press and Public Relations, Computer Department, Administration

Computer Department

Andreas Wohlschläger (head)

The reconceptualization of the computer department that started in October 2002 has now been completed. Headed by a senior researcher who is still actively involved in research, it now fully meets the scientific needs of the institute. The computer department also houses the electronics workshop, the mechanics workshop, and the video/audio facilities, so that technical service can be provided in an integrated fashion.

Computers and Network

The MPI has retained the network structure introduced in 1990. The local network is organized in a radial pattern (fast ethernet) with a gigabit optical fiber backbone. It currently connects about 220 computers. The optical fiber cable hooks up directly with the Munich University Net run by the Leibniz Computing Center. This university net continues to provide access to the computer center of the Max-Planck-Institut für Plasmaphysik at Garching, responsible for routing into the science net. Database programs (Oracle, PostgreSQL) and statistics packages (SAS, SPSS, BMDP) are still available at the compute servers. However, high-performance PCs meanwhile have almost completely taken over the tasks of the file and compute servers (SPSS, Matlab, Statistica, Mathematica). We were thus able to slim down the server net from 8 to 1 machine, the latter one being a new server operating under LINUX. It also serves as a platform-independent internal webserver, a network-administration server, and as the external webserver. These three services are using a common PostgreSQL database, such that the former distributed information can now be administered centrally.

Video/Audio

Various facilities are available for making audiovisual recordings and analyzing the behavior of research participants. Complete S-VHS facilities consist of two to three flexibly mounted, remote-controlled color cameras with zoom and wide-angle lenses in the observation rooms, and one to two recorders with time-code generation (VITC, LTC) and color mixers in the technical rooms. Additional cabling enables hooking up recorders, monitors, and PCs in both the technical and observation rooms. VHS and S-VHS camcorders are available for use outside the institute. There is an electronic editing station with three professional S-VHS-standard video-recorders for processing the recordings. This station can be controlled with FAST over an editing control unit as well as a PC workstation with an integrated video machine.

Electronics Workshop

This workshop provides all the necessary equipment to carry out inhouse most of the electronic work needed. Its main duties are to adapt or design peripheral units, but also to service and repair research instruments, PCs, printers, and video systems.

Mechanics Workshop

The mechanics workshop is responsible for designing, developing, constructing, and producing all mechanical research equipment. It contains the technical equipment for milling, turning, drilling, woodwork, and so forth. The demands of the new junior research groups and the Baby Lab are keeping the mechanics workshop busier than ever, showing how essential it is for the institute.

Administration

Josef Kastner (head)

The joint administration works for the Max Planck Institute for Psychological Research as well as the Max Planck Institute for Foreign and International Social Law, both housed in the same building. It supports the institutes' managing directors in fulfilling their ample administrative tasks in accordance with the by-laws of institutes and the Max Planck Society Statutes.

The admin is in the service of all the employees, the junior scientists, and foreign guest scientists; it is in charge of procuring research equipment and all other furnishings; of organizing and maintaining infrastructure; of planning and budgeting institutional and third-party funding; as well as the regular clearing and settlement of income and expenditures.

In addition, in the period covered by the report the department accomplished both a reorganization of the salary-accounting system and the implementing of a personnel-administration system (under SAP-HR).

Department for Cognition & Action, Research Units

Cognition & Action

The laboratory area of this department houses, in one wing of the second floor, 15 air-conditioned and sound-proof test booths of 2.6 to 4.8 m^2. The entire lab is equipped with various digitizing tablets, numerous special input-devices constructed by the electronics and mechanics workshop, an electromagnetic Polhemus system, and LCD shutter-glasses.

Infant Cognition and Action

Our laboratory consists of five rooms on the third floor. The parents' and babies' waiting room offers cooking and nursing facilities. The two test rooms are air-conditioned and connected to the observation room by one-way mirrors. One test room is equipped with a stage, a touch screen, and three DOME cameras, the other with two computer monitors, two DVD-Players, and two DOME cameras. The observation room is equipped with two digital video-systems (DVC Pro Panasonic) for recording and analysis. The fifth room serves for off-line video analyses and therefore provides two units, each consisting of a monitor and a digital video-recorder connected to a PC. Off-line analysis is conducted with the *Interact* software package. In addition, a PC with special video software is used to prepare video presentations.

Cognitive Psychophysiology of Action

Our main laboratory is equipped with two 32-channel DC amplifiers. Presentation is run by a VSG 2/5 (Cambridge Research Systems) video controller that enables temporally fully controlled visual presentation of stimuli with high spatial and color resolution. In addition, the VSG 2/5 controls the triggering of EEG recording and response recording. Different response devices can be connected to this system, including digital and analogue (force-sensitive) response keys. In a sound-proof cabin, participants are seated in an armchair, which is adjustable in height so as to control their position with regard to the visual stimuli on the screen.

A second laboratory with a single 32-channel AC amplifier serves for developing experimental setups. The equipment for visual presentation is the same as in the main lab. Both EEG amplifier and visual equipment are portable and can also be used in a new, recently installed cabin that allows recordings with the participant lying down. Thus, fMRI experiments can be evaluated by emulating at least participants' posture.

Cognitive Robotics

The Cognitive Robotics group uses three commercial robot setups. The first setup is a modular robot arm with six rotatory degrees of freedom and a linear two-finger gripper (amtec GmbH). The arm is mounted in a hanging position on a metal frame and operates on a table underneath. The table lies in the visual field of a pan-tilt unit (Directed Perception, Inc.) that carries two color cameras. All units are controlled by a PC running Linux. The second setup is a wheeled mobile robot platform („Pioneer", ActivMedia Robotics, LLC) with a vision system similar to that of the robot arm. The robot is controlled by an onboard PC and through a radio Ethernet link. The third setup is another wheeled mobile robot platform („Koala", K-Team S.A.), which is used in the EU project „Artificial Mouse". This robot has two pan-tilt units with cameras and an onboard PC with radio Ethernet link. For neural network simulations, we use a cluster of 10 PC's, connected by Gigabit Ethernet. Several software packages for the parallelization of neural network training have been developed by the group.

Sensorimotor Coordination

Our laboratory is equipped with an Optotrak 3020 3D motion measurement system, which can currently record the position of 24 infra-red markers. The haptic interface consists of two Phantom 1.5 robots. Two Nano-19 force/torque transducers, are attached to the tip of each robot, allowing measurement of reaction forces exerted by the subjects in perturbation or virtual reality experiments. Electromiographic (EMG) measurements are done with a 16-channel 15LT Amplifier System from Grass Telefactor Inc. A variety of electrodes (for surface and needle EMG) are available in the lab. Crank-rotation experiments will be done on a platform containing a Panasonic torque motor and two Mini-45 force/torque transducers.

Differential Behavior Genetics

Two rooms located on the third floor are equipped for psychological assessment. The seating arrangements permit an individual administration of paper-and-pencil tests and tape-recorded qualitative interviews. Experimental tasks requiring the recording of reaction times are presented through PCs equipped with ERTS software and other programs developed with PASCAL. Audiometric screening is performed with a Hortmann Selector 20K apparatus for determining hearing thresholds on sinus tones. Vision is measured through Landolt figures provided on small and large OCULUS displays and through a Pelli-Robson sensitivity chart.

Advisory Board, Scientific Members, Scientific Staff, Office and Technical Staff, Guest Scientists

Scientific Members

Prof. Dr. Wolfgang Prinz (Executive Director)
Prof. Dr. Franz Emanuel Weinert († 7.3.2001)

External Scientific Member

Prof. Dr. Dietrich Dörner

Advisory Board

Prof. Dr. Vicki Bruce (Stirling, UK)
Prof. Dr. Steven Hackley (Columbia, USA)
Prof. Dr. Reinhold Kliegl (Potsdam, Germany)
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Prof. Dr. Rolf Pfeifer (Zürich, Switzerland)
Prof. Dr. David Rosenbaum (University Park, PA, USA)
Prof. Dr. Rolf Ulrich (Tübingen, Germany)
Prof. Dr. Carlo Umiltà (Padova, Italy)

Guest Scientists

Tony Greenwald (1. - 31.5.2001)
Asher Koriat (7.10. - 29.2.2004)
Kevin O'Regan (1. - 19.7.2003)
Bob Proctor (1. - 31.7.2002)
Joelle Proust (1.9.2002 - 28.2.2003)
Bruno Repp (15.6. - 14.7.2002)
Orit Rubin (19.6. - 11.7.2001)
Maggie Shiffrar (1.6. - 31.7.2003)
Michael Spivey (1. - 30.6.2003)
Jan Theeuwes (1.7. - 31.7.2001)
Steve Tipper (1. - 31.8.2001)
Carlo Umiltà (1. - 31.3.2003)

Staff

Department for Cognition & Action

Prof. Dr. Wolfgang Prinz (Head)

Senior Researchers

Prof. Dr. Thomas Goschke (April 2000 to March 2002), Dr. Marc Grosjean (as of March 2002), PD Dr. Dirk Kerzel (until March 2002), Dr. Günther Knoblich, PD Dr. Iring Koch, Prof. Dr. Sabine Maasen (until Aug. 2001), Prof. Dr. Jochen Müsseler, Dr. Martina Rieger, Dr. Andreas Wohlschläger

Postdoctoral Research Fellows

Dr. Rayna Azuma (until March 2001), Dr. Annette Bolte (until March 2002, DFG), Dr. Knut Drewing (until Oct. 2002), Dr. Rüdiger Flach (until Sept. 2003), Dr. Peter Keller (as of Sept. 2002), Dr. Franz Mechsner (until Dec. 2002), Dr. Katharina Müller-Schmitz (until Dec. 2002, MPG), Dr. Gertrude Rapinett (as of Oct. 2003), Dr. Thomas Splett (as of Sept. 2002, VW), Dr. Sonja Stork (DFG), Dr. Tillmann Vierkant (VW), Dr. Bettina Walde (until Aug. 2002, VW), Dr. Florian Waszak (until Aug. 2003), Dr. Peter Wühr (until Sept. 2001, DFG)

Predoctoral Research Fellows

Patric Bach, Simone Bosbach, Chiara Begliomini (until Oct. 2003), Avner Caspi (until June 2002, MINERVA-Foundation), Sara de Maeght (until Feb. 2002), Ulrich Drost, Kai Engbert, Michael Öllinger, Andrea Philipp, Bettina Pollok (until April 2002), Stefanie Schuch, Natalie Sebanz, Prisca Stenneken (until Oct. 2002), Matthias Weigelt

Office and Technical Staff

Silvia Bauer, Angelika Gilbers, Irmgard Hagen, Heide John, Nicola Korherr, Regina Schuberth, Ursula Weber

Research Units

1. Infant Cognition and Action

Senior Researchers
PD Dr. Gisa Aschersleben (Head), Dr. Birgit Elsner (until Sept. 2002), Dr. Petra Hauf (as of Oct. 2001), Dr. Annette Hohenberger (as of Sept. 2003, Procter & Gamble)

Predoctoral Research Fellows
Bianca Jovanovic (until Feb. 2003), Annette Klein (as of Jan. 2003), Tanja Hofer (as of July 2002)

Office and Technical Staff
Inga Gegner, Gabriele Karn, Maria Zumbeel

2. Cognitive Psychophysiology of Action

Senior Researcher
PD Dr. Edmund Wascher (Head)

Predoctoral Research Fellows
Ivonne Buhlmann (as of mid-March 2003), Monika Kiss (DFG), Andrea Schankin (as of mid-Oct. 2002), Katrin Wiegand, Maren Wolber, Selina Wriessnegger

Technical Staff
Stefanie Ahrens (until June 2003)

3. Cognitive Robotics

Senior Researchers
Dr. Ralf Möller (Head; until July 2003), Dr. Bruno Lara Guzman (until March 2003), Kim DaeEun

Predoctoral Research Fellows
Heiko Hoffmann, Wolfram Schenck (until Oct. 2003)

Technical Staff
Henryk Milewski

4. Sensorimotor Coordination

Senior Researcher
Dr. Rafael Laboissière (Head, as of Sept. 2001)

Postdoctoral Research Fellow
Ken Ohta

Predoctoral Research Fellows
Anne Häberle (as of May 2003), Michiko Inoue (as of March 2003)

Technical Staff
Vitor Torres

5. Moral Development

Senior Researchers
Prof. Dr. Gertrud Nunner-Winkler (Head), Dr. Marion Nikele

Project Member
Doris Wohlrab (as of Oct. 2002, BMBF)

Office and Technical Staff
Veronika Stroh (until March 2001), Ilse Tarabichi

6. Differential Behavior Genetics

Senior Researcher
Dr. Ulrich Geppert (Coordinator)

Office and Technical Staff
Adelheid Pretzlik, Heidi Schulze, Erica von Wurm-Seibel (until July 2003)

Service Units

Library and Scientific Information

Dr. Frank Halisch (Head), Ellen Bein, Renate Boës, Ludwig Rickert, M.A.

Press and Public Relations

Dr. Monika Nißlein (Research Coordinator)

Computer Department

Dr. Andreas Wohlschläger (Head), Fiorello Banci, Karlheinz Honsberg, Henryk Milewski, Axel Römmelmayer, Andreas Schmidt, Max Schreder

Administration

Josef Kastner (Head), Brigitte Albrecht (until July 2003), Assol Arnhold (trainee), Annemarie Batzek, Jutta Czöppan, Brigitte Ederer (until April 2003), Daniela Gratzl, Elfriede Hurmer, Karl-Heinz Katzbach, Silvia Klemm, Christine Moser (as of April 2003), Hans Puchberger, Michael Reinert, Hermann Spiegl, Ingeborg Theimer (until Dec. 2002)

Max Planck Institute
for human cognitive and brain sciences
department of psychology

Amalienstr. 33 · D-80799 Munich · Germany
Phone +49 (0) 89 / 38 602-0 · Fax +49 (0) 89 / 38 602-199
www.cbs.mpg.de