

Inner and outer bodily information processing: evidence in adolescence

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BACKGROUND. Given the impact of bodily information processing on physical and mental health (e.g., Khalsa et al., 2018) there is a growing interest in the topic. However, despite this appreciation, the developmental trajectory of inner and outer bodily information processing across the lifespan remains under-researched, particularly during adolescence.

AIM. To explore the development during adolescence of different interoceptive dimensions, that is, interoceptive accuracy (IAcc), sensibility (ISe) and awareness (IAw), and action-oriented (aBR; i.e., body schema) and nonaction-oriented (NaBR; i.e., visuo-spatial body map) body representations (BR).

MAIN RESULTS. Group differences in three dimensions of interoception and in aBR and NaBR were determined using independent t-tests or Mann-Whitney U tests, as appropriate. Concerning internal bodily processing, adolescents were as accurate as young adults in counting their heartbeats (Mann-Whitney U= 1141; p= .39; Figure 3, Panel A). However, they showed less metacognitive awareness of their interoceptive ability ($t_{97}=2.1$; $p<.05$; Figure 3, Panel A) and scored significantly different from young adults on ISe questionnaires (Figure 3, Panel B). Furthermore, the correlational analysis showed a lack of significant associations between the interoceptive dimensions in both adolescents (all ps > .26) and young adults (all ps > .17). In the outer body processing, adolescents were slower than young adults in performing mental rotation of body parts (Mann-Whitney U= 864; $p < .01$; Figure 4, Panel A) and less accurate in locating body parts (Mann-Whitney U= 910; $p < .05$; Figure 4, Panel B).

MATERIALS AND METHOD. Fifty-four adolescents (33 girls; mean age = 13.3 yrs., SD = 0.7) and forty-seven young adults (28 women; mean age = 25.7 yrs., SD = 3.9) took part in the study. Participants were given tasks probing inner and outer bodily processing.

Inner Body Processing Assessment:

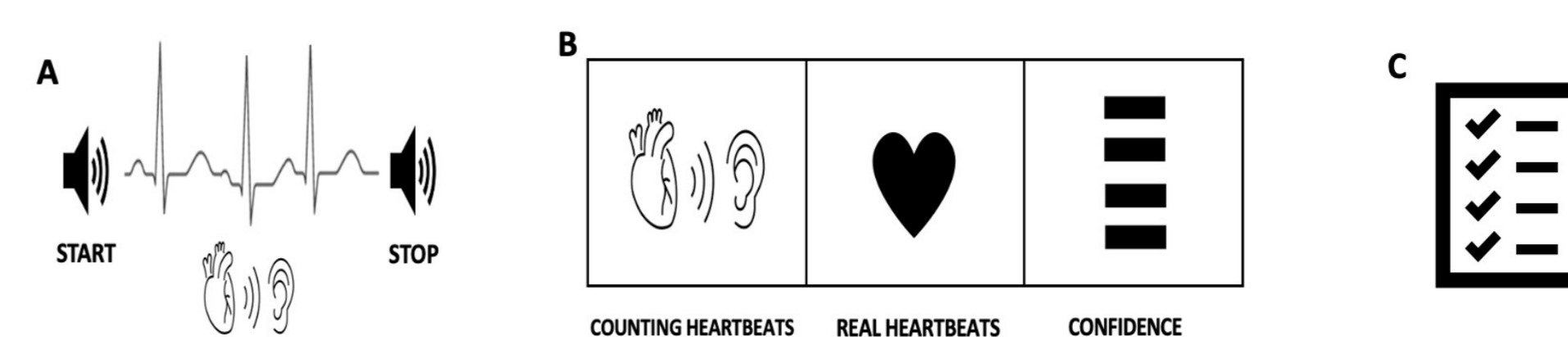


Figure 1. (A) IAcc was assessed with the *Heartbeat Tracking Task* (Schandry, 1981; adaptation for children: Koch & Pollatos, 2014); (B) IAw was calculated through a correlation between confidence and accuracy in heartbeats tracking (Garfinkel et al., 2015); (C) ISe was assessed with the *Self-Awareness Questionnaire* (SAQ; Longarzo et al., 2015; adaptation for children: Raimo et al., submitted) and with the *Multidimensional Assessment of Interoceptive Awareness* (MAIA; Mehling et al., 2018; adaptation for children: Jones et al., 2021).

Outer Body Processing Assessment:

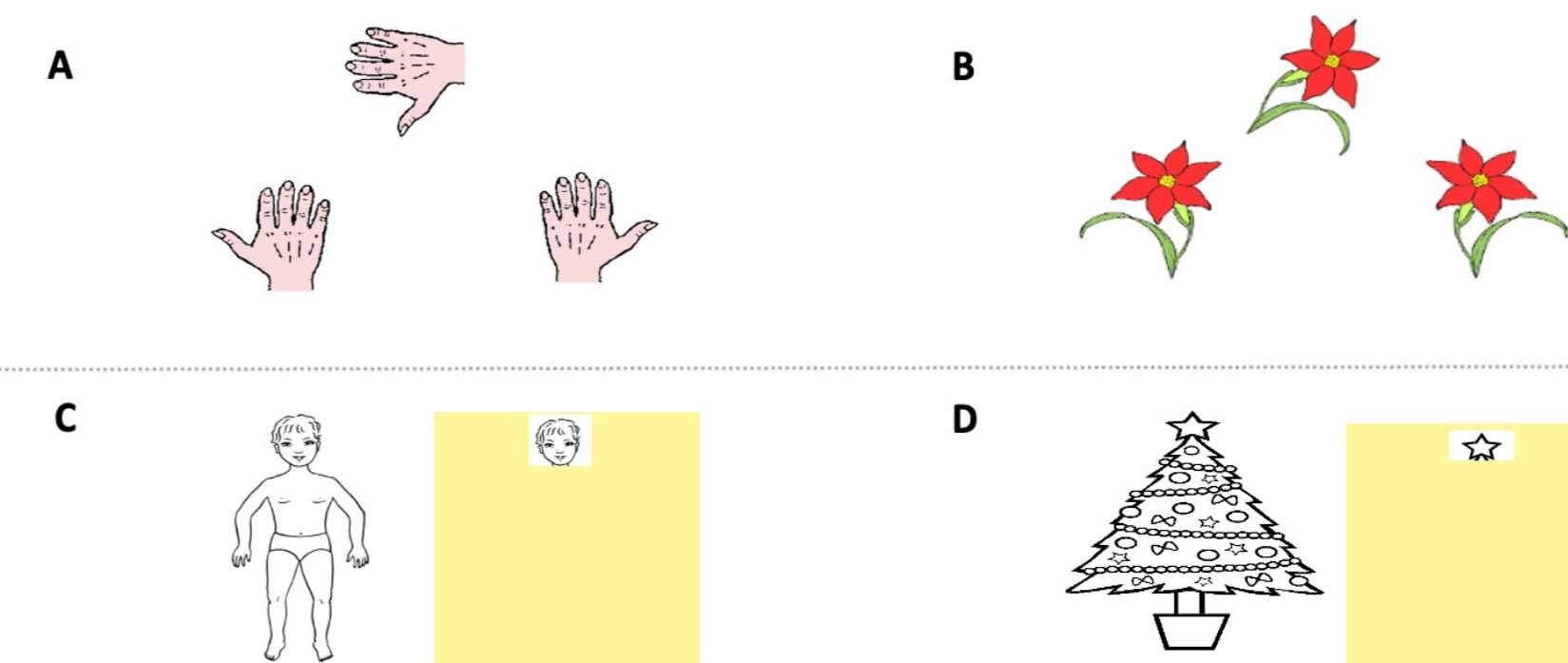


Figure 2. Examples of tasks involving body (left) and non-body (right) processing. (A) aBR was assessed with the *Hand Laterality Task* (HLT; Raimo et al., 2021; adapted from Parsons, 1987); (C) NaBR was assessed with the *Frontal Body Evocation* task (FBE; Raimo et al., 2021; adapted from Daurat-Hmeljiak et al., 1978).

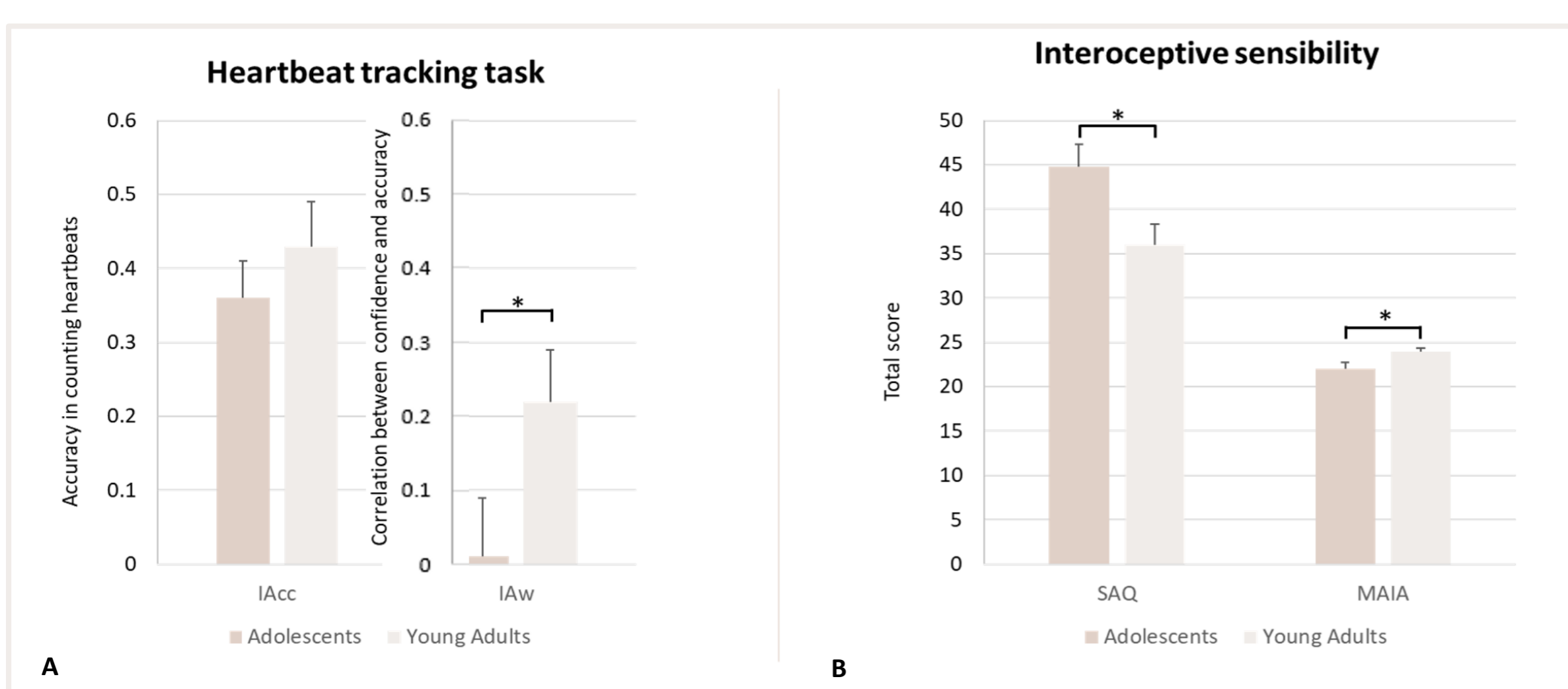


Figure 3. Interoceptive accuracy (IAcc) and awareness (IAw) on the Heartbeat tracking task (Panel A) and interoceptive sensibility as measured with the SAQ and MAIA (Panel B) in the two groups.

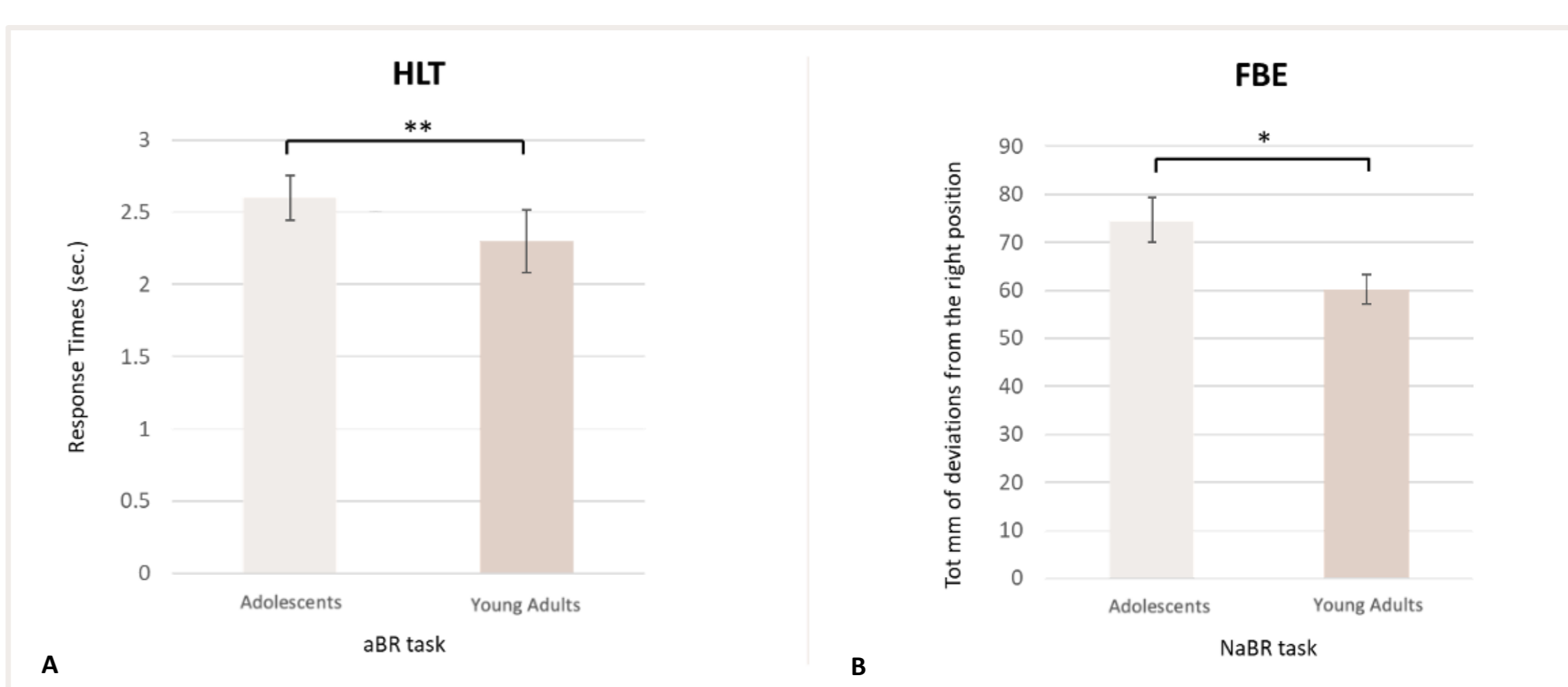


Figure 4. Performance on aBR (Panel A) and on NaBR (Panel B) tasks in the two groups. * $p < .05$; ** $p < .01$

DISCUSSION. The adolescents' performance on objective behavioural measures probing different kinds of bodily information suggests an adult-like pattern of performance in processing interoceptive information (IAcc) but not in representing sensorimotor and visuo-spatial bodily information.

Also, as already proved in studies on adults (Garfinkel et al., 2015), current results indicate that the three interoceptive dimensions (IAcc, IAw, ISe) are independent, and their maturation follows different trajectories during adolescence.

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