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Interoceptive accuracy and body awareness – Temporal and longitudinal associations in a non-clinical sample

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ABSTRACT

Objective: Various aspects of interoception are regarded as temporally stable phenomena. This study investigates the temporal stability of and longitudinal associations between interoceptive accuracy (as measured with heartbeat tracking task) and a related concept, body awareness (assessed by self-report).
Methods: In a two-month longitudinal study 103 university students (31% male, 23.34 ± 4.34 yrs.; 44 Hungarians; 36.4% male, 21.4 ± 1.67 yrs. and 59 Norwegians; 25.4% male, 24.8 ± 5.09 yrs) were investigated using Schandry's heartbeat tracking task and the Body Awareness Questionnaire.
Results: Both interoceptive accuracy and body awareness showed good test-retest reliability ($r = 0.60$ and $r = 0.73$, respectively; $p < 0.001$ in both cases). The two concepts were independent of each other at baseline ($r = 0.06$, $p = 0.587$), and did not predict each other over an eight weeks period of time.
Conclusion: Self-reported body awareness and objectively measured interoceptive accuracy are temporally stable and not related to each other.

1. Introduction

Interoception, the sense of the physiological condition of the body [14] has a significant role in psychological functioning. For example, it provides the basis for the self and self-awareness, has a significant contribution to decision making [3,19,20,29,81], and it appears to be altered in several disorders, for example in somatoform [83] and panic disorders [96].

Genuinely, interoception is defined as the sensation of various internal signals arising from the body [15–17]. Although there is a general agreement among researches that it is a multidimensional construct [31,32,46], there is no consensus regarding the number and the name of the components. First, 'interoceptive accuracy' ([11], p. 20123; [31,37,60]) or 'interoceptive sensitivity' [35,102] refer to the accuracy of perception/detection of interoceptive signals. It is assessed with behavioral (i.e. objective) measurements, such as the heartbeat perception or tracking task and the detection or discrimination tasks [84,101]. Second, 'interoceptive awareness' [11] or 'sensibility' [31,35,37,60], also called 'metacognitive interoception' [102] is measured with questionnaires, and defined as the self-reported or perceived interoceptive ability. Finally, some authors distinguish a further aspect, called 'interoceptive awareness', and also 'metacognitive awareness of interoceptive accuracy', e.g. confidence-accuracy correspondence [35,37]. This paper does not focus on this third aspect, and refers to self-reported interoception as interoceptive awareness (IAw). There is an additional concept, called 'body awareness' that has been developed before the modern definition of interoception. Body awareness, that refers to the beliefs about one's sensitivity to normal body processes and changes [88], represents a more integrative approach to subjective body experience, that is generally based on the integration of several interoceptive sensory channels, as well as exteroceptive modalities. According to a recent definition ([62], p. 4), "Body awareness is the perception of bodily states, processes and actions that is presumed to originate from sensory proprioceptive and interoceptive afferents and that an individual has the capacity to be aware of." As the definition emphasizes the involvement of perceptual processes and conscious awareness, this construct shows considerable overlaps with the dimension of interoception called interoceptive awareness or sensibility. The construct of body awareness can be very well explained by the modern evolutionary approach to interoception, which emphasizes the adaptive importance of multimodal integration of body related information in the mid-insula [16]. This integrated feeling of the body plays a role in homeostatic regulation, the generation of the feeling of being alive, and also in the emergence of emotional feelings [16]. It is

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not clear, however, how individual interoceptive channels may contribute to and change body awareness. The aim of this study is to investigate the temporal stability of and the relationship between interoceptive accuracy (IAc) and a related concept, body awareness (BA).

For the measurement of IAc with the focus on the heartbeats, two major approaches have been developed. The tracking or perception methods compare the number of the perceived and measured heartbeats [59,84]; while during the detection tasks subjects discriminate between their own heartbeats and rhythmic external signals [13,49,101]. Both tracking [78,79] and discrimination methods [50,69] were criticized for being influenced by factors that are not inherent part of interoception, and it was questioned also whether they measure the same phenomenon [37,51,71]. This paper does not aim to decide this debate, but distinguish between the two methods consequently.

IAc measured with the heartbeat tracking and detection methods is described by previous studies as a stable trait-like characteristic [2,40]. According to the literature, there are three major arguments that support this notion. First, only the minority of the interventions designed to manipulate IAc had been successful. Second, IAc is associated with trait-like psychological variables. Third, there are findings that directly demonstrate the temporal stability of IAc. We critically review the empirical evidence supporting these arguments and investigate to what extent they really support the stability and trait-likeness of interoceptive accuracy.

Concerning the first argument, the most direct way to improve IAc is to provide feedback to the participants on their performance [44,45]. Empirical studies demonstrated, however, that such changes of IAc have to be interpreted cautiously, as the improvement may be only due to participants' updated knowledge or belief about heart rate [78,79]. Schaefer and her colleagues developed a new method to improve heartbeat tracking using feedback [82], but avoiding the pitfalls of previous studies [86] mentioned above. Although there was no significant difference between intervention and wait list in the level of IAc, a significant reduction in state symptoms of somatoform disorders was observed after training, which was interpreted as an indicator of improvement of heartbeat perception [82]. There are other methods and techniques that are assumed to improve IAc, but the majority of the studies show poor effectiveness. For example, there was no difference between long-term Buddhist meditators (N = 11) and nonmeditators (N = 17) in IAc measured with the detection task [66]. A study, also using detection task with a bigger sample size (N = 16 Kundalini and 13 Tibetan Buddhist meditators) and a matched control (N = 15) found similar results [47]. Other cross-sectional studies using various tracking tasks also reported null findings [63,67]. A longitudinal research did not find any change in cardiac perception following either a one week long (N = 80), or an eight weeks long (N = 19) mindfulness meditation training [68]. Moreover, although cognitive-behavior therapy reduced the symptoms of panic disorder, it did not change the accuracy of heartbeat tracking [5]. Similarly, in a four weeks long intervention study on a comprehensive behavioral program, the accuracy of heartbeat perception improved from 0.498 to 0.591 (N = 42), but the change did not reach the threshold of significance [64]. One of the studies that showed a significant improvement of IAc measured with the tracking task involved two subsamples (N = 77 and 79) receiving contemplative training for 9 months, and a third group (N = 78) participating in social-affective training for 3 months [8]. Differences with small to medium effect sizes were found after 6 months (Cohen's d = 0.173 after 6 months, and 0.273 after 9 months). Another recent study investigated the effect of an 8-week body scan intervention on the heartbeat perception ability [33], and reported mixed results. One of the sub-studies found no difference between the body scan group (N = 25) and the control group (N = 24) that listened to an audio book; while the other sub-study found increased mean IAc scores (significant change from 0.53 ± 0.20 to 0.65 ± 0.19; N = 18) in the body scan group, but not in the inactive control group (N = 18).

There is another line of research aiming to temporarily manipulate IAc by varying experimental conditions. For example, manipulations like the inclusion of a mirror [3,97], or asking the participants to look at a photograph of their own face [2] were successfully utilized both with heartbeat tracking and discrimination methods. There are a few studies that applied biological manipulations to modulate the level of IAc. In one study, isoproterenol infusion was used to increase the heart rate. After treatment, altered cardiac sensations were found in all 15 participants, in a dose-dependent manner [48]. Another research investigated the effects of variations in stroke volume, and found that it did not influence either heartbeat detection, nor the location of the sensation [80]. Other studies investigated the impact of stress; for example, female participants showed a significant decline of heartbeat detection during a demanding mental arithmetic task [30]. The anticipation of public speech marginally improved heartbeat perception in a sample of subjects with high and low social anxiety [90]; similar results were reported investigating a non-anxious sample [25]. On the other hand, IAc measured by tracking task did not increase but decreased after the experience of social exclusion [26]. Finally, a recent study indicates that directing the attention to romantic partners' face during the heartbeat perception task improves the accuracy scores of people with low IAc [58]. In summary, there is limited evidence indicating that situational factors might cause temporary fluctuations in IAc. The results of training are controversial: some methods did not change the level of IAc significantly, while in some cases it is not clear, whether the change in heartbeat perception/detection can be explained by improved IAc.

As for the second argument (i.e. IAc is related to temporally stable characteristics), a review on heartbeat perception and detection techniques in anxiety and anxiety disorders included six studies on trait anxiety and IAc, and found a significant association with small to medium weighted mean effect size (d = 0.37, SD = 0.13, 95% CI [0.1–0.64], N = 202) [23]. A research that had not been included in this review reported similar findings (r = 0.20, p = 0.028) [74], while another study did not find a significant connection (r = − 0.09, p = 0.36) [24]; both studies used tracking task. Findings regarding alexithymia, another trait-like characteristic, are less consistent. There was no significant correlation between heartbeat perception and different dimensions of alexithymia as assessed by the Bermond/Vorst Alexithymia Questionnaire (N = 60) [22]. Conversely, there was a moderate inverse association between IAc measured with tracking task and the scores of the Toronto Alexithymia Scale (TAS) (p = − 0.37, p < 0.01, N = 155) [42]. Furthermore, a study found that antisocial behavior, another temporally stable feature, predicts reduced heartbeat detection scores [65]. On the other hand, IAc was not related to borderline disorder [40] assessed by detection task, trait mindfulness [68], or any of the Big Five personality factors [32] measured with tracking tasks. In summary, associations between IAc and trait-like characteristics are not conclusive regarding the temporal stability of IAc. On the one hand, this is due to the empirical evidence presented above, but also to the very nature of this popular argument. In more detail, from the lack of association between two traits can not be directly concluded that any of them is not a trait. Even for the studies that reported positive associations, the existence of a third variable explaining the connections can not be excluded.

Finally, we have empirical findings that directly (i.e. through multiple measurements) support the temporal stability of IAc. Pollatos and her colleagues estimated a test-retest reliability of the tracking task up to 0.81, but the exact sample size and the time interval between the measurements were not specified [42,75]. A study investigating 42 patients receiving therapy belonging to various diagnostic categories reported strong test-retest correlation of heartbeat perception in a four weeks period (r = 0.58, p < 0.001) [64]. Parkin and her colleagues, who investigated the effect of mindfulness training, found high test-retest reliability of the tracking task after a week in two studies (N = 60 in each; r = 0.70 and r = 0.80, p < 0.001 in both cases), and a