THE CONNECTION BETWEEN INTEROCEPTIVE SENSITIVITY AND ANXIETY

The study of temperament's role in explaining the connection

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Interoception has important role in many psychological phenomena such as emotional experience. Previous studies suggest that interoception provides a link between biological and psychological processes in many clinically relevant disorders and it has been most frequently connected to various forms of anxiety. Individuals with anxiety tend to be more sensitive to interoception; anxiety is characterized by somatic symptoms and increased attention to autonomic bodily processes supporting a relationship between these variables.

Brain research has brought new evidence on individual differences in brain areas´ and their functioning in explaining differences in interoceptive sensitivity. There are some studies suggesting that inherent temperament traits are also linked to same brain areas as interoception. This suggests a link between interoception and individual differences in emotional reactivity and temperament traits, forming a possible prerequisite for anxiety in some individuals.

The main purpose of this study was to investigate the connection between interoceptive sensitivity and anxiety and how temperamental traits, especially negative emotionality, are explaining the connection between the variables. It was hypothesized that there is a positive connection between interoceptive sensitivity and experience of anxiety and that temperament traits related to negative emotionality are connected to both interoceptive sensitivity and anxiety, mediating their connection. Interoceptive sensitivity was measured by heart beat detection task, the most widely applied in interception studies. Anxiety and individual temperament traits were measured by self-report questionnaires.

Results of this study show no direct link between interoceptive sensitivity and anxiety, suggesting that high-anxiety individuals are not more sensitive to their interoceptive information than others. Also, negative emotionality was connected only to anxiety, not interoceptive sensitivity. Instead of negative emotionality, temperamental inhibition and low attentional control seems to explain both interoceptive sensitivity and anxiety. These results are in line with the current understanding that some mental health disorders such as anxiety disorders have a connection to misrepresented interoceptive signals or failure to anticipate changes in interoceptive states. Temperamental traits might be a potential background factor having an effect to this bias.

Key words: Interoception, interoceptive sensitivity, anxiety, temperament, inhibition, attentional control, heart beat detection task

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Interoseptio eli kehoaisti vaikuttaa emotionaalisen kokemuksen ja monen muun psykologisen ilmiön taustalla. Aiemmat tutkimukset osoittavat, että interoseptio on yhteydessä useisiin kliinisesti merkittäviin häiriöihin, vaikuttaen häiriöiden biologisiin ja psykologisiin prosesseihin. Interoseptio on useimmiten liitetty ahdistushäiriöihin. Ahdistukseen taipuvaiset yksilöt ovat tyypillisesti herkempiä interoseptiiviselle tiedolle; ahdistukseen liittyy erilaisia somaattisia oireita sekä lisääntynyt tarkkaavaisuus autonomisen hermoston reaktioille ja kehon tuntemuksille, mikä tukee yhteyttä näiden välillä.

Aivotutkimuksella on saatu uutta näyttöä aivoalueiden toiminnasta ja niiden yksilöllisistä eroista, mikä puolestaan selittää eroja interoseptioherkkyydessä. Jotkut tutkimukset esittävät myös, että synnynnäiset temperamenttipiirteet ovat yhteydessä samoihin aivoalueisiin kuin interoseptio. Näin ollen interoseption ja emotionaalisen reaktiivisuuden sekä temperamenttipiirteiden välillä vaikuttaa olevan biologispohjainen yhteys, joka voi selittää, miksi toiset ihmiset ahdistuvat herkemmin.

Tämän tutkimuksen keskeisenä tavoitteena oli tutkia interoseptioherkkyyden ja ahdistuksen välistä yhteyttä, ja miten temperamenttipiirteet, erityisesti negatiivinen emotionaalisuus, vaikuttaa yhteyteen. Hypoteesina oli, että interoseptioherkkyyden ja ahdistuksen välillä on positiivinen yhteys, ja temperamenttipiirteistä negatiivinen emotionaalisuus on yhteydessä molempiin muuttujiin. Interoseptioherkkyyttä mitattiin sydämensykkeen tunnistustehtävällä, joka on laajimmin käytetty menetelmä interoseptiotutkimuksissa. Ahdistuksen kokemusta ja temperamenttipiirteitä tutkittiin kyselylomakkein.

Tutkimuksen tulokset osoittavat, että interoseptioherkkyyden ja ahdistuksen välillä ei ole suoraa yhteyttä. Ahdistukseen taipuvaiset yksilöt eivät ole muita herkempiä kehon sisäisille aistimuksilleen. Lisäksi negatiivinen emotionaalisuus oli yhteydessä ainoastaan ahdistukseen, ei interoseptioherkkyyteen. Negatiivisen emotionaalisuuden sijaan temperamenttiin liittyvä inhibitio sekä vähäinen tarkkaavuuden kontrollointi olivat yhteydessä sekä interoseptioherkkyyteen että ahdistukseen. Tulokset tukevat nykykäsitystä, jonka mukaan mielenterveyden häiriöihin, etenkin ahdistukseen, liittyy kehoaistimusten väärintulkitsemista tai vaikeuksia ennakoida kehonsisäisten tilojen muutoksia. Temperamentti voisi vaikuttaa yhtenä taustatekijänä tähän vääristymään.

Avainsanat: Interoseptio, kehoaisti, interoseptioherkkyys, ahdistus, temperamentti, inhibitio, tarkkaavuuden kontrollointi, sydämensykkeen tunnistustehtävä

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INTRODUCTION

Interoception has become widely studied topic within psychology and neuroscience in recent decades. Besides maintaining bodily homeostasis, interoception has important role in many psychological phenomena such as emotional experience, self-regulation, decision-making and even consciousness (Khalsa, Feinstein, Simmons, & Paulus, 2018). Interoception provides also a link between biological and psychological processes in numerous mental health conditions and disorders and it has been most frequently connected to various forms of anxiety (for a review, see, Domschke, Stevens, Pfleiderer, & Gerlach, 2010; Khalsa et al., 2018; Paulus & Stein, 2010). According to those studies, individuals with anxiety tend to be more sensitive to interoception; anxiety is characterized by somatic symptoms and increased attention to autonomic bodily processes supporting a relationship between these variables.

Brain research has brought new evidence on individual differences in brain areas´ and their functioning in explaining differences in interoceptive sensitivity (Critchley, Wiens, Rothstein, Ohman, & Dolan 2004) as well as subjective awareness and emotional experience (Craig, 2002, 2009; Critchley & Garfinkel, 2017). Temperament as a biological construct is closely related to emotions and their regulations (Rothbart, Ahadi, & Evans, 2000) and there are some studies suggesting that inherent temperament traits are also linked to those same brain areas as interoception (Terasawa, Shibata, Moriguchi, & Umeda, 2013). This suggests a link between interoception and individual differences in emotional reactivity and temperament traits, forming a possible prerequisite for anxiety in some individuals.

In this study main interest will be on investigating the connection between interoceptive sensitivity and anxiety and how temperamental traits, especially negative affect, are explaining the connection between these variables. Interoceptive sensitivity will be measured by heartbeat detection task, the most widely applied in interception studies, and anxiety and individual temperament traits will be measured by self-report questionnaires. It is assumed to find a previously suggested link between high interoceptive sensitivity and anxiety within normal healthy population. As recent studies show contradictory evidence of their connection (Krautwurst, Gerlach, Gomille, Hiller, & Withöft, 2014; Petersen, Van Staeyen, Vögele, Von Leopoldt, & Van Der Bergh, 2015), aim is to also study whether there are some individual temperamental differences acting as background factors to both interoceptive sensitivity and anxiety and having effect on the connection between them. Since temperament has not been widely studied related to interoceptive sensitivity, this study might give new insight on individual differences and connections.

Interoception – subjective experience of the body state

Interoception is the perception of the state of the body. Its main function is in maintaining an individual's bodily homeostasis and allostasis (Craig, 2002, 2009). It is a concept important in understanding the human psychosomatic processes and in broader sense it includes the ability of visceral sensory impulses to directly or indirectly affect behavior by either reaching or not reaching conscious awareness (Cameron, 2001). Within years the definition has evolved from examining mostly the physiological aspects of interoception (Dworkin, 2007) or classical interoception, meaning the encoding and representation of internal bodily signals reporting the body's physiological state (Craig, 2002) to more broad and inclusive as the study of the interoception has gained wider interest in different areas of psychology (see review study of interoception definitions by Ceunen, Vlaeyen, & Van Diest, 2016). Interoception is not just visceral sensations but refers to process where information coming from inside the body is integrated into the central nervous system (Ceunen et al., 2016). Thus, interoception should be defined as a subjective experience of the body state and a product of the central nervous system involving higher order processing. Interoception starts when there is a higher order integration of sensory and neural information taking place to form a body state representation in the brain. This definition and its appearance is in line with increased interest in brain research and development of various neuroimaging techniques. The emphasis and interest has turned to find the neural basis of interoception.

Recent findings in brain research confirm there are distinct interoceptive pathways, e.g. specific neural circuitry through which visceral signals influence various brain processes and shape human cognition and behavior (Critchley & Harrison, 2013). "Interoceptive neural network" comprise the somatosensory and somatomotor cortices, the insular cortex, anterior cingulate cortex and prefrontal cortices (Craig, 2009; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004). The anterior insula is an area that may link representations of the outside world with the body's internal state, acting as potential basis for emotional experience and reactiveness (Farb, Segal, & Anderson, 2013). This area seems to be important for all subjective human feelings, their processing and regulation (Herbert & Pollatos, 2012).

As interoception seems to be involved in both cognition and emotion, the measurement of individual differences in interoceptive ability or sensitivity is broadly relevant phenomenon to psychology. Bodily sensations can arise from various internal organs, such as heart and gut. Studies show that there are significant individual differences in interoceptive awareness (Herbert & Pollatos, 2012). Interoceptive awareness is suggested to have several different features such as interoceptive

attention, detection, discrimination, accuracy, insight, sensibility and self-report (Garfinkel, Seth, Barrett, Suzuki, & Critchley 2015; Khalsa et al., 2018). Interoceptive accuracy or interoceptive sensitivity, refers to correct and precise monitoring of internal sensations that can be objectively measured in research conditions (Khalsa et al., 2018). The term interoceptive sensitivity (IS) will be used in this study. Basic research related to IS has mostly focused on cardiovascular interoception, e.g. heartbeat perception and the individual sensitivity for cardiac signals (Herbert & Pollatos, 2012). This sensitivity has been usually experimented by using different heartbeat detection tasks such as tracking or discrimination tasks (Khalsa & Lapidus, 2016, review of cardiac interoception).

Neuroimaging studies confirm the link between interoception and performance on tests of interoceptive sensitivity, showing activation in anterior cingulate and insular cortices (Craig, 2002, 2004; Critchley et al., 2004; Pollatos, Schandry, Auer, & Kaufmann, 2007; Schulz, 2016). These studies show that good compared to poor heartbeat perceivers demonstrate greater activation, especially in the right anterior insular cortex. Activation during interoceptive tasks has been found both in healthy population and in clinical patients (see metastudy of the methods used to study cardiac interoception by Khalsa & Lapidus, 2016). Also sensitivity to one's heartbeat has been found to have connections to individual differences in emotional reactiveness and in that way to psychological wellbeing and disorders (Critchley et al., 2004), with many studies linking interoceptive sensitivity especially to anxiety disorders, as well as mood disorders, eating disorders, addictive disorders, somatic symptom disorders, and others (Khalsa et al., 2018). As some recent brain studies have also confirmed the previously suggested link between emotional reactivity, temperament traits and interoception (Terasawa et al., 2013), it deserves further investigation.

Differences in emotional reactiveness and regulation are connected to inherent temperamental traits and processes

Interoception has been throughout the history linked to the study of emotions and their biological basis. Temperament can be defined as the tendency to express particular emotions with a certain intensity, reflecting individual, inherent and rather permanent differences (Keltikangas-Järvinen, 2004). Hence, temperament is closely related to emotional reactiveness and regulation. Temperament explains the style and the amount of emotional responses and it is possible that emotion regulation styles and temperament cannot even be separated (Rothbart, Ahadi, & Evans, 2000).

The early James–Lange theory of emotion proposed that emotional feelings arise from the mind's perception of bodily changes in response to emotional stimuli which affect our thoughts (for a reference, see Gendron & Barrett, 2009). Later Schachter and Singer's theory stated that a change in bodily arousal triggers and provides the intensity to emotion, followed by cognitive appraisal of the likely cause of the arousal (Schachter & Singer, 1962). The idea that emotions are dependent on physiological changes, followed by or accompanied with cognitive evaluation of the context, has proved relatively robust and shared also by current research; some kind of cognitive processing to be made between the physiological response and the perception of the emotion to make meaning of the response (Barrett, 2012, 2017). Therefore the experience of emotion is at least large extent subjective.

Psychobiological models of temperament have been focusing on emotional and motivational aspects of temperament. According to Derryberry and Rothbart (1988) most models and theories of temperament sees emotional reactivity, arousal (avoid/approach) and ability to self-regulate as general biologically based constructs of temperament. These are linked with basic affective–motivational systems including approach or positive affect, inhibition or negative affect, fear, frustration or anger, as well as attentional system including effortful control (Derryberry & Rothbart, 1997; Rothbart, Ahadi, & Evans, 2000).

Arousal refers to physiological and psychological state of being reactive to stimuli (Derryberry & Rothbart, 1988). Distinction can be made between central and peripheral forms of reactivity. Central reactivity is assumed to reflect cortical arousal and it covers reactivity of perceptual and cognitive processing. With peripheral reactivity is referred to individual differences in autonomic response. Introverts, compared to extraverts, seem to possess more reactive cortical pathways, having greater reactivity. Introverts attain an optimal level of arousal at relatively low levels of stimulation and thus enjoy and approach milder forms of stimulation than extroverts.

Gray (1970) proposed that two basic emotional systems, approach and behavioral inhibition systems, affecting arousal and forming psychophysiological basis of extraversion-introversion. Extraversion is linked to approach systems, causing extraverts to be more sensitive to signals of reward, more sensitive to emotions of hope and relief, and to being more impulsive in their behavior. Introversion on the other hand is linked to behavioral inhibition systems, leading to a greater sensitivity to signals of punishment and non-reward, greater fear and frustration, and behavior which is characterized by anxiety. To conclude this, extraversion is typically linked to positive emotionality and approach and introversion to negative emotionality and behavioral inhibition. However, according to Derryberry and Rothbart (1988), it is important to note that these emotional systems are not unidimensional - persons high on negative affect are not necessarily low in positive affect and

vice versa. Individuals, whether more extroverts or introverts, may thus demonstrate different patterns of emotionality, with different combinations of positive and negative affect.

Self-regulation refers to the individual's ability to actively control arousal and emotional responses (Derryberry & Rothbart, 1988). Ability to inhibit action can be separated into low-level inhibition control already seen in infancy and to more higher level attentional control not driven by emotions but involving cognitive and more conscious component that are used to interpret internal or external information (Derryberry & Rothbart, 1997). Introverts can more easily draw attention to a negative stimulus than extraverts (Derryberry, 1987). Also approach, avoidance and inhibition have been suggested to predict cognitive control abilities (Prabhakaran, Kraemer, & Thompson-Schill, 2011). In their study, extraversion trait sensitivity was associated with increased ability to ignore task-irrelevant information in the verbal domain. Higher avoidance trait sensitivity was associated with decreased ability to ignore task-irrelevant information in the nonverbal domain.

State and trait anxiety reflects inherent temperamental traits and processes

In terms of temperament, anxiety can be seen as a result of above mentioned temperamental processes of arousal and emotion as well as self-regulation (see integrative review of emotion regulation and anxiety by Cisler, Olatunji, Feldner, & Forsyth, 2010). The distinction of state and trait anxiety is relevant to show the multi-faceted aspects of anxiety and temperamental processes. State anxiety can be defined as an unpleasant emotional arousal in the face of threatening demands or dangers (Lazarus, 1991). A cognitive appraisal of threat is necessary for the experience of this emotion. Trait anxiety, on the other hand, reflects the existence of stable individual differences in the tendency to respond with state anxiety in the anticipation of threatening situations (Lazarus, 1991). These temperament-personality traits related to trait anxiety include concepts such as emotionality, negative affect including fear and sadness, introversion or behavioral inhibition and neurotism (Goldsmith & Lemery, 2000; Rothbart et al., 2000). Also, in adult personality studies, fearful motivation, or behavioral inhibition, is often related to a general dimension of neuroticism or negative emotionality (Larsen & Ketelaar, 1989; Watson & Clark, 1992). In line with this, Gray (1970) have argued that neurotic introverts are especially likely to experience anxiety symptoms.

To regulate attention is a significant component of individual differences in temperament. Previous research has supported a relation between measures of attentional control and anxiety (Healy & Kulig, 2006). In Healy and Kulig's study, high scores on trait anxiety were correlated with inability to regulate attention in response to the environment, and enhanced attentional control may interact

with dimensions of temperament to modify the effects of generalized anxiety. It is suggested that anxious and impulsive psychopathology may reflect limitations in reactive fear-related attentional processes and more voluntary effortful control, which can take the form of overregulation as well as underregulation (Derryberry & Rothbart, 1997). Hence, anxious subjects can more easily draw attention to negative stimuli than non-anxious subjects (MacLeod, Mathews, & Tata, 1986).

Previous studies suggest links between interoceptive sensitivity, temperament and anxiety

As already stated, there are numerous studies and findings connecting interoception with emotions, about interoception's role in anxiety and anxiety related disorders, as well as relation between specific temperament traits and anxiety. However, studies investigating temperamental traits' relation to interoceptive sensitivity, at least within healthy population, is not yet comprehensively studied. Most of the studies are investigating the role of negative emotionality in connection to interoception and anxiety.

Already one earlier study on cardiac interoception found a connection between cardiac interoceptive sensitivity, anxiety and the personality trait Emotional Lability (Schandry, 1981). Individuals who showed good perception of their heart beat activity (counting heart beats) exhibit higher levels of a momentarily experienced anxiety and were scoring higher on the personality trait Emotional Lability. Schandry concluded that higher self-reported anxiety is due to better perception of physiological processes rather than to actual level of autonomic arousal. In other study Ludwick-Rosenthal and Neufeld (1985) found some evidence of positive correlations between interoceptive sensitivity and high state anxiety with less emotional expressiveness. In a third study, good heartbeat detectors reported more general levels of intense negative affect as well as more anxiety and depressive symptomatology but not more intense positive affect (Critchley et al., 2004).

A relationship between interoceptive sensitivity and negative emotional traits and states are found in several studies suggesting greater attention to one's bodily state may contribute to the development of intense negative emotions and anxiety (review of the studies, see Domschke et al., 2010). In a study by Petersen, Van Staeyen, Vögele, Von Leupoldt and Van Den Bergh (2015) participants with higher self-reported symptoms in daily life scored higher on negative affect and reported more symptoms during the experimental task. They were also marginally more accurate in the interoceptive classification task. Correlation between Negative Affect ratings and symptom reports has typically been found in clinical as well as non-clinical populations (Van Dienst et al., 2005).

Brain research has also confirmed the link between interoception and negative emotional states. Critchley et al. (2004) found intercorrelations between right anterior insula activity, interoceptive sensitivity and subjective negative emotional experience (measured by various questionnaires). Also Terasawa et al. (2013) found that increased right anterior insular activation, during when participants were attending to their bodies, was positively correlated with social anxiety and neuroticism and the lack of agreeableness, openness to experience and extraversion (self-reported). Increased right insular activation has also been widely linked with anxiety (Terasawa et al., 2013), and behavioral inhibition and avoidance motivation in general (Craig, 2014), reflecting differences between introverts and extraverts.

Connection between interoceptive sensitivity and anxiety – contradictory results

Domschke et al. (2010) overviewed several studies in which trait anxiety was connected to interoception (heartbeat perception) and found out that all but one study showed positive correlations between individual interoceptive sensitivity and anxiety level. These studies suggest that greater attention to one's bodily state may contribute to the development of intense negative emotions, anxiety and anxiety disorders. Vice versa, individuals high on anxiety performed better in tasks requiring interoceptive sensitivity and seemed more interoceptively aware. In some clinical studies, patients with increased anxiety sensitivity as well as panic disorder and other anxiety disorders generally show superior performance on interoceptive sensitivity tasks (Ludwick-Rosenthal & Neufeld,1985; Ehlers & Breuer, 1996).

However, some studies show contradictory results; clinical patients with anxiety or panic disorder may perform poorly in interoception tasks (Van der Does, Antony, Ehlers, & Barsky, 2000). Yet they may stay generally focused on their internal bodily events. There might be various explanations for these contradictory results, starting from different experimental settings or clinical participant groups. Also, Critchley et al. (2004) points out that distinction should be made "between neural mechanisms that support attention to interoceptive states and those that support accurate perception of interoceptive information". In fact, there are findings supporting this notion. When perception of somatic sensations is measured by self-report questionnaires, patients with different anxiety related disorders and anxiety sensitivity generally report hypervigilance for somatic sensations (Domschke et al., 2010). It is also suggested that anxiety disorders are linked to failures to appropriately anticipate changes in interoceptive states, such as reduced ability to adequately report interoceptive afferents or exaggerated response to aversive interoceptive afferents (Paulus & Stein, 2010).

Aim of the study

The main purpose of this study was to investigate the connection between interoceptive sensitivity and anxiety within healthy population. Based on the acknowledged connection between interoception and anxiety (Domschke et al., 2010), it was hypothesized that there is a positive connection between interoceptive sensitivity and self-reported experience of anxiety (referring to prolonged state anxiety). Secondly, aim was to investigate whether temperament traits related to negative emotionality (referring to trait anxiety) were connected to both interoceptive sensitivity and anxiety, possibly mediating their connection. Because temperament as an inherent characteristic seems to play a role in experiencing anxiety, it might also explain individual differences in interoceptive sensitivity, as temperament has been shown to reflect the same brain areas and neuroanatomy as interoception (Terasawa et al., 2013). It was hypothesized that temperament traits related to negative emotionality, in this study negative affect (Derryberry & Rothbart, 1997), have positive correlation to both interoceptive sensitivity and experience of anxiety, serving as a possible link between these variables. Thirdly, as typically only a few temperament traits have been studied with respect to interoceptive sensitivity, the aim was also to find out whether there are other relevant temperament traits connected to both interoceptive sensitivity and anxiety, which might also shed more light to their connection. The study was executed using heartbeat detection task for measuring interoceptive sensitivity and self-report questionnaires for measuring anxiety and temperamental traits.

METHODS

Participants

This study was part of a larger research project 'Body awareness, brain and exercise' which started in fall 2015 as part of a collaboration between the Department of Psychology and the Faculty of Sports and Health Sciences at the University of Jyväskylä. The aim of the project was to investigate the relations between interoception, body awareness, personality and exercise as well as to look for group differences in brain functioning using Magnetoencephalography (MEG). For the study 3 groups of individuals were recruited; athletes, non-athlete active exercisers and non-athlete individuals (exercising less than 2 hours a week). Data was collected in two sessions. First session consisted of

the heartbeat detection task and questionnaires. It was carried out in the laboratory in the faculty of psychology. The second session was MEG study with heartbeat detection task and it took place in the MEG laboratory.

Altogether 71 participants (29 male, Mage = 24.48, SD = 3.94) were recruited using mainly student mailing lists and notice boards at the university of Jyväskylä and the University of Applied Sciences. Inclusion criteria for participating in this study were age between 18 and 35, normal Body Mass Index (not over 25) and no metal in the body. These criteria we based on previous findings showing that body mass and age may influence performance in the interoceptive task (Murphy, Geary, Millgate, Catmur & Bird, 2018) and metal in the body can disturb MEG measurements. Participants were invited to perform two heartbeat detection tasks in separate sessions, during which they completed questionnaires measuring temperament and personality traits, clinical anxiety and depression symptoms, wellbeing, emotion intensity, and physiological and exercise related background information (heart rate and body mass index).

In this study only results from the heartbeat detection task conducted during the second session in the MEG laboratory is reported due to more controlled conditions to minimize external effects. This narrowed the sample for 50 (22 male, Mage = 24.46, SD = 3.89) participants. In the second interoception measurement session, participants were prepared for MEG and ECG measurements, instructed about the experimental task and seated in a chair.

Participants provided an informed consent before the experimental treatment. An approval for the experiment was received from The Ethical Committee of the University of Jyväskylä. The research was conducted in accordance to the ethical standards of the American Psychological Association (APA).

Measurements

Interoceptive sensitivity

Interoceptive sensitivity (IS) was measured as performance on a heartbeat detection task during a MEG measurement. The stimuli were presented on a screen with a distance of 105 cm from the subject. Participants performed both a heartbeat detection task and an auditory detection task. In each tasks, participants were presented with 96 trials consisting of 20 auditory stimuli through earphones with an individually adjusted volume. The auditory stimulus was locked to each heartbeat either

simultaneously (simultaneity condition, 50%), or with a delay of 40% of the duration of previous inter-beat interval (nonsimultaneity condition, 50%). The auditory stimulus was a 800 Hz, 100 ms tone (nondeviance condition), but on half of the trials, one slightly deviant 785 Hz, 100 ms target tone was randomly interspersed in between the other tones (deviance condition). The analysis of IS was made using both simultaneity and non-simultaneity tasks.

During the heartbeat detection task (interoception trials), the participants were instructed to focus on their heartbeat, and this was indicated by an image of heart on the screen. At the end of each trial, a response probe window was presented. The participants responded with one of two assigned buttons to a yes/no probe whether the tone was simultaneous with their heartbeat or not. During the auditory detection task (exteroception trials), participants were instructed to focus on the tone, indicated by an image of a note on the screen. Correspondingly to the simultaneity task, participants responded whether there was a deviant tone played during the trial (deviance condition) or not (nondeviance condition). Immediately following the interoception and exteroception tasks, respectively, participants evaluated their performance on a scale from one (random guessing) to five (100% certainty).

Questionnaires

Temperament traits was measured with one scale, the Adult Temperament Questionnaire (ATQ) (Evans & Rothbart, 2007, Finnish version, translated by Katri Räikkönen-Talvitie and the Developmental Psychology Research Group of University of Helsinki). ATQ is 77-item self-report questionnaire for adults measuring the general temperamental constructs of Effortful control, Extraversion/Introversion, Negative affect, and Orienting sensitivity, all measured on a 1–4 Likert scale.

Participant's experienced anxiety symptoms in everyday life were measured using Beck's Anxiety Inventory (BAI) invented for clinical use (Beck & Steer, 1993). BAI is a 21-item self-report questionnaire used to measure (prolonged) state anxiety, measured on a 4-point Likert-type scale. Beck, Epstein, Brown, & Steer (1988) included two components in the BAI's original proposal: cognitive and somatic, although anxiety can be thought of as having several components, including cognitive, somatic, affective, and behavioral components. The cognitive subscale provides a measure of fearful thoughts and impaired cognitive functioning with 7 items, and the somatic subscale measures the symptoms of physiological arousal, with 14 items (Armstrong & Khawaja, 2002).

Statistical analysis

The statistical analyses were done using IBM Statistics SPSS 24. To test whether background variables such as gender were correlated with interoceptive sensitivity, Pearson's and Spearman's correlation coefficients were calculated (t-tests). Correlation analysis between interoceptive accuracy and questionnaire scores were calculated using Pearson's correlation coefficients as well. Interoceptive sensitivity was handled as a continuous variable.

Multivariate regression analyses were conducted to test further the connection between interoceptive sensitivity, anxiety and various temperament traits. Missing data were handled by substituting them with participant or scale mean, respectively, where applicable.

RESULTS

Background factor gender and variables

Background factor gender showed no correlations with the interoceptive sensitivity variable (IS). No significant correlations were found between gender and BAI general index. When comparing gender to BAI's somatic and cognitive subscales, no significant differences were found between gender and any cognitive items. Females and males reported cognitive symptoms equally. When compared gender with somatic symptoms, significant difference ($p<.05$) was found between gender and sub-item difficulty in breathing as well as gender and sub-item heart pounding/racing ($p< .05$) suggesting females report generally more somatic symptoms.

There were significant differences ($p<.05$) between females and males in ATQ Negative affect scale and its subscales Fear and Sadness, females rating themselves as sensing more negative emotions. Significant difference was also found in Extraversion subscale High Intensity Pleasure ($p<.05$), males rating higher in this scale.

Connections between interoceptive sensitivity, anxiety and temperament traits

Interoceptive sensitivity and anxiety scores were not significantly correlated with each other. However, there were significant correlations between temperament traits (ATQ) with both interoceptive sensitivity (IS) and anxiety score (BAI). Tables 1 and 2 illustrate correlations within the variables. Only significantly correlated subscales are shown on tables.

Table 1. Correlations between Interoceptive sensitivity and temperament traits (ATQ)

	IS	NEGAFF	EFFCON	Actcon	Attcon	EV	Sociab	Posaff	ORSENS
IS	1								
NEGAFF	0,072	1							
EFFCON	-0,277	-,611**	1						
Actcon	-,313*	-,531**	,824**	1					
Attcon	-,317*	-,546**	,808**	,552**	1				
EV	-0,258	-,427**	0,146	0,197	,288*	1			
Sociab	-,313*	-,370**	0,221	,456**	0,151	,783**	1		
Posaff	-,417**	-0,046	0,123	0,019	0,214	,540**	0,268	1	
ORSENS	-0,003	,416**	-0,176	-,287*	-0,052	-0,047	-0,106	0,047	1

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
IS=Interoceptive sensitivity; NEGAFF=Negative Affect; EFFCON=Effortful Control; Actcon=Activation Control; Attcon=Attentional Control; EV=Extraversion; Sociab= Sociability; Posaff=Positive Affect; ORSENS=Orienting Sensitivity

Those significant correlations found were all negative. Effortful Control subscales Attention Control and Activation Control correlated negatively ($p<.05$) with Interoceptive sensitivity, along with Extraversion subscales Sociability ($p<.05$) and Positive Affect ($p<.01$). No significant correlations were found between Interoceptive sensitivity and scales Negative Affect or Orienting Sensitivity.

Table 2. Correlations between anxiety score and temperament traits (ATQ)

	BAI	NEGAFF	Fear	Sad	EFFCON	Attcon	EV	Sociab	Hiplea	Posaff	ORSENS	Affsens
BAI	1											
NEGAFF	,437**	1										
Fear	,536**	,754**	1									
Sad	,345*	,752**	,432**	1								
EFFCON	-,408**	-,611**	-,549**	-,418**	1							
Attcon	-,455**	-,546**	-,580**	-,286*	,808**	1						
EV	-,417**	-,427**	-,492**	-0,136	0,146	,288*	1					
Sociab	-,314*	-,370**	-,479**	-0,118	0,221	0,151	,783**	1				
Hiplea	-,282*	-,415**	-,437**	-0,22	-0,01	0,249	,767**	,363**	1			
Posaff	-,300*	-0,046	-0,046	0,124	0,123	0,214	,540**	0,268	0,094	1		
ORSENS	,312*	,416**	0,232	,556**	-0,176	-0,052	-0,047	-0,106	-0,023	0,047	1	
Affsens	,331*	,381**	0,189	,526**	-0,22	-0,112	-0,078	-0,077	-0,057	-0,025	,922**	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

BAI=Anxiety score; NEGAFF=Negative affect; Sad=Sadness; EFFCON=Effortful control; Attcon=Attentional control; EV=Extraversion; Sociab=Sociability; Posaff=Positive affect; ORSENS=Orienting Sensitivity; Affsens=Affective Perceptual Sensitivity

Negative Affect ($p<.01$) and its subscales Fear ($p<.01$) and Sadness ($p<.05$) were positively correlated to Anxiety self-report (BAI) as well as Orienting Sensitivity ($p<.05$) and its subscale Affective Perceptual Sensitivity ($p<.05$). Effortful Control ($p<.01$) and its subscale Attention Control ($p<.01$) were negatively correlated to BAI as well as Extraversion ($p>.01$) and all its subscales Sociability ($p<.05$), High Intensity Pleasure ($p<.05$) and Positive Affect ($p<.05$).

Regression models explaining interoceptive sensitivity and anxiety

Based on results from correlational analysis separate regression models were formed for both Interoceptive Sensitivity and Anxiety to analyse further which temperament traits together best explains each of them. The purpose was to verify the results from correlational analysis with the model that includes all the potential variables. Maximum of four variables were added due to small sample size (n=50), thus only statistically most significant temperament subscales were included into regression analysis.

In the first regression model, the one explaining Interoceptive Sensitivity, only subscale Positive Affect seems to have statistically significant main effect (36 %) when four temperament subscales are put to the model. Using hierarchical regression, the model best explaining interoceptive sensitivity is Model 2 (see Table 3). Temperament subscales Positive Affect and Activation Control together explains 23.5 % of the interoceptive sensitivity. Sociability or Attentional Control have no statistically significant effects in the model.

Table 3. Hierarchical regression analysis: Model that best explains interoceptive sensitivity

	Interoceptive Sensitivity				
	Model 1	Model 2	Model 3	Model 4	
Independent variables	β	β	β	β	r
Positive Affect	-,417**	-,411**	-,388**	-,357*	-,417**
Activation Control		-,305*	-,265	-,188	-,313*
Sociability			-,088	-,114	-,313*
Attentional Control				-,120	-,317*
	aR2=.157*	aR2=.235**	aR2=.225*	aR2=.217*	

**p<.01 *p<.05

Positive Affect and Activation Control both have negative connection to interoceptive sensitivity; high interoceptive sensitivity is connected to low positive affectivity - experiencing less frequently positive feelings, and low activation control - being less able of performing an action when there is a strong tendency to avoid it.

Temperament subscales Fear, Attentional Control, Positive Affect and Affective Perceptual Sensitivity were added to the linear regression model explaining anxiety.

Table 4. Linear Regression Analysis: Temperament subscales' connections to Anxiety

	Anxiety (score)	
Independent variables	β	r
Fear	,395**	,536**
Attentional Control	-,147	-,455**
Positive Affect	-.245*	-,300*
Affective Perc. Sens.	.233*	,331*
	R2=.429 F(4, 45) = 8,460***	

***P<.001, ** p < .01, * p <.05

These subscales explains 43 % of variance of experienced anxiety. Results show that fear has strong positive connection to anxiety together with affective perceptual sensitivity, e.g. sensitivity to perceive emotional aspects of issues. Positive affect shows negative connection to anxiety; the more experiences of positive feelings less experienced anxiety. Out of Extraversion subscales Positive affect (which is not correlated to either Sociability or High Intensity Pleasure, as seen on Table 2) was the only subscale that had effect on the regression model. Ability to focus attention had no statistical significance in this model despite its strong negative correlation to anxiety.

DISCUSSION

Aim of the study was to investigate the connection between interoception and anxiety. The hypothesis was that interoceptive sensitivity and experience of anxiety are positively connected. The study showed no connection between interoceptive sensitivity and experience of anxiety (state anxiety), contrary to majority of previous studies in the field. Aim was also to investigate what role individual differences in temperament play in relation to interoceptive sensitivity and anxiety; whether temperament traits related to negative emotionality (Negative Affect in this study) were connected to both interoceptive sensitivity and anxiety, possibly mediating their connection. Hypothesis was that temperament trait Negative Affect have positive correlation to both interoceptive sensitivity and experience of anxiety. This hypothesis was not confirmed either. Study showed that Negative Affect and its subscales Fear and Sadness were positively connected only with anxiety, but no significant connection was found between those variables and interoceptive sensitivity.

Thirdly, aim was to find out whether there are other relevant temperament traits connected to both interoceptive sensitivity and/or anxiety. Indeed, interoceptive sensitivity and anxiety variables shared some temperamental traits; both were negatively connected to Extraversion subscales Positive Affect and Sociability as well as Effortful Control subscale Attentional Control (inability to focus or shift attention effectively). Further regression analysis showed that Positive Affect was the only subscale having significant main effect in both models explaining interoceptive sensitivity and anxiety. As there was no direct correlation between interoceptive sensitivity and anxiety, conducting regression analysis regarding temperament trait's possible mediating effects between these variables was not possible. Additionally, regression analysis showed also that other Effortful Control subscale, Activation Control, had significant negative main effect and connection to interoceptive sensitivity.

High-anxiety individuals are not more sensitive to their interoceptive information than others

The main hypothesis that high-anxiety individuals, in terms of both state and trait anxiety, seem to be more sensitive to their own interoceptive information has been confirmed in many studies (Critchley, 2004; Domschke et al., 2010) but was not supported by this study. Result is more in line with the studies that have shown no or "altered" connection between the variables (Van der Does et al., 2000). Hence, interoceptive sensitivity itself might not be best in explaining the experienced anxiety or at

least there is no direct connection between them. As Terasawa et al. (2013) concluded regarding the contradictory results, there is no clear understanding within brain research of the function of insular activity in situations that evoke negative emotions and whether it represents interoceptive sensitivity or an exaggerated emotional autonomic response. In this sense, current research in the field is more in line with the results of this study.

Negative affect is related to experienced anxiety but not to interoceptive sensitivity

The second hypothesis of negative emotionality's connection to both interoception and anxiety was not confirmed either. Temperamental trait Negative Affect was not related to interoceptive sensitivity. This is an interesting result since negative emotionality and especially fear has been previously connected to interoception (Domske et al., 2010). Also in brain research insular activity and interoception have been both connected to negative emotionality, especially social fear (Stevens et al., 2011; Terasawa et al., 2013). However, strong positive connection between Negative Affect and experienced anxiety is in line with previous research (see for instance Watson, Clark, & Carey, 1988; Goldsmith & Lemery, 2000; Nigg, 2006). As expected, Negative Affect, with its subscales Fear and Sadness, seems to be important temperamental trait in explaining anxiety and in that way seems to act as a prerequisite for anxiety. Hence, it can be argued, that there is a clear negative emotional basis for anxiety but probably not for interoception.

Low positive affectivity and low sociability are connected to both interoception and anxiety

Results of this study showed that instead of negative affectivity, low Positive Affectivity and Sociability seems to play a significant role in both interoceptive sensitivity and anxiety, which was further strengthened by regression analysis. So far there seems to be only a few studies investigating directly the connection between temperamental trait positive affectivity or extraversion and interoception (see study related to alexithymia and interoceptive awareness by Ernst et al., 2014). There are also findings that suggests a neural connection between temperamental inhibition or avoidance motivation (as opposite to positive affect and sociability) and interoception (see Craig, 2004, 2014; Lyyra & Parviainen, 2018). Terasawa et al. (2013) found in their study that the activation in the anterior insular cortex was positively correlated with levels of anxiety and neuroticism and negatively correlated with agreeableness and extraversion suggesting that interoceptive processing

mediates bodily sensation and anxiety level. Also, previous research show that positive affect, or lack of it, has been typically related to social anxiety or phobias. Studies, summarized by Kashdan, Weeks, and Savostyanova (2011), have shown that higher social anxiety is associated with less frequent, lower intensity, and less lasting positive experiences.

It can be argued that low positive affect and low sociability are specific forms of temperamental inhibition linked to introversion, suggesting that instead of negative emotionality, interoceptive sensitivity might be related to emotional ("less reactiveness") inhibition as well as inhibition in social situtions. Term behavioral inhibition, on the other hand, is closely linked to negative emotionality and refers to the consistent tendency to demonstrate fear and withdrawal especially in novel situations (Svihra & Katzman, 2004) and can act as a predictor for anxiety. Thus, regarding interoceptive sensitivity it might be useful to differentiate between different aspects of inhibition and limit it to include emotional and social inhibition. It seems highly pausible that introversion, and especially focusing on one's "internal world", as is shown in high interoceptive sensitivity, is not as such a necessity or prerequisite to negative feelings or potentially evolving mental health problems. Separation of low positive affect and behavioral inhibition is supported also by a study of Laptook, Klein, Olino, Dyson and Carlson (2010), where low positive affect was associated with low approach across most contexts, whereas behavioral inhibition was associated with low approach only in novel situations.

Self-regulation plays a role in both interoception and anxiety

Both interoceptive sensitivity and anxiety were negatively connected to Effortful Control subscale Attentional Control (ability to focus or shift attention effectively). This temperamental trait's connections to interoceptive sensitivity has not been profoundly studied but there are general neuroanatomical findings that neural activity in insular cortex is related to attention, inhibition and interoception (for instance Craig, 2009). In their study, Weiss, Sack, Henningsen and Pollatos (2014), suggested a positive connection between interoception and self-regulation. They found that in pain perception, interoceptive sensitivity was associated with better self-regulation capacities measured by HSRI questionnaire (measuring 5 aspects of self-regulation). Contrary to this, the results of this study suggest that interoceptively sensitive individuals are less able to effectively shift their attention or activate performance.

Previous research related to anxiety shows that better attentional control can buffer against generalized anxiety and high scores on trait anxiety has been correlated with inability to regulate

attention (Healy & Kulig, 2006), result being in line with this study. Experience of anxiety was indeed connected to lower Effortful Control, especially Attentional Control. Hence, attentional control seems essential in regulating one's emotional state, result being also in line with Derryberry and Reed's study (2002). In their study, adults with better attentional control were more adept at engaging and disengaging from the varied aspects of their environments which enables greater regulation of internal affective states such as anxiety. The model proposed by Lonigan and Vasey (2009) suggests further that the relation between negative affect and anxiety disorder is moderated by the quality of effortful control. As this study showed, both Negative Affect and Attentional Control are connected to experience of anxiety and they are also negatively connected to each other (see Table 2 on result section). Thus, ability to control effectively one's attention and regulate emotions seems important in anxiety.

Why are interoceptive sensitivity and anxiety not connected?

Based on the results of this study, it seems clear that the connection between interoception and anxiety is more complex and contradictory than many previous studies suggest. To analyze further the role of inherent temperament traits in relation to both interoceptive sensitivity and experience of anxiety might offer possible explanation to these contradictories. It can be argued that temperament is modifying the emotional reactiveness and regulation "style" which further have influence on both interoceptive sensitivity and anxiety. Interoception as a biological construct seems connected to temperamental inhibition, but their causality is not clear. The main difference between interoception and anxiety is that experience of anxiety is mostly formed by negative emotionality although temperamental inhibition also seems to play a role as a background factor in anxiety. There are also differences in terms of effortful control. High interoceptive sensitivity might be linked to "inhibition" of attentional or activational control; e.g. the more individuals are focused on their internal bodily signals, less flexible they are in general shifting attention or less flexible activating their performance properly when needed. In anxiety, attention control seems to interact with negative emotionality, such as fear, along with inhibition. The more anxious individuals are, less effective they are shifting their attention away from fear related stimuli especially. This is in line with Healy et al. (2006) who concluded that in anxiety, attentional control interact with other characteristics of temperament, i.e., fearfulness, inhibition, or being hesitant to approach unfamiliar persons or situations, supporting or leading to generalized anxiety.

The disconnection between interoceptive sensitivity and anxiety found in this study suggest that negative emotionality and introversion are separate construct, contrary to many temperament theories (for instance Gray, 1970). To separate introversion and negative emotionality has got evidence from the studies where neuroticism has been shown to have more negative impact on happiness and subjective well-being than introversion has. In Young and Bradley's study (2008), no significant difference was found between stable introverts and stable extraverts in well-being and happiness, while neurotic introverts and extraverts demonstrated less wellbeing and happiness. Also other studies suggest that instead of extraversion, emotional stability seems to have major effect on well-being (Hills & Argyle, 2001a, 2001b).

Anxiety as attentional bias to interoceptive information?

Although there seems not to be a direct connection, it can be assumed that interoceptive sensitivity has a role in experience of anxiety. It is plausible that other factors, especially cognitive, might determine how individuals are interpreting their bodily signals, whether being sensitive or non-sensitive to them.

There are evidence for this assumption. Petersen et al. (2015) investigated the relationship of accuracy and bias in interoception as well as individual differences in negative affect and symptom report in daily life on both of them. Individuals higher in negative affect as well as symptom report were only marginally more accurate in an interoceptive classification task (respiratory stimuli). Along with it, participants higher in negative affect and symptom report had significantly increased bias in overestimating intensity of stimuli, but only for more ambiguous stimuli. Also Krautwurst et al. (2014) suggested that it is not a heightened interoceptive sensitivity but the bias in overestimating harmless somatic cues that are more relevant for the maintenance of health anxiety. This results was supported also by their study with patients with pathological health anxiety (Krautwurst, Gerlach, & Witthöft, 2016). This suggest that anxiety-prone individuals, although typically more focused on their bodily state, are not necessarily any accurate than others. Attentional system of anxious individuals may be distinctively sensitive to and biased in favor of threat-related stimuli in the environment (Bar-Haim, Lamy, Lee, Bakermans-Kranenburg, & van IJzendoorn, 2007). A large meta-analysis of cognitive bias in anxiety confirmed that a significant threat-related bias was present in anxious participants (in every anxious groups) but not in non-anxious participants (Bar-Haim et al., 2007).

Other research stream related to anxiety has demonstrated that cognitive factors indeed play an important role in the development and maintenance of anxiety disorders (e.g. Beck, 1988; Clark,

1999). Cognitive theorists have indicated that individuals with an anxiety disorder appear to be sensitive to a systematic bias in cognitive processing which is due to cognitive misinterpretation of the physical or psychosocial experience of anxiety as catastrophic or dangerous (Amstrong & Khawaja, 2002). Also current neurobiological research suggest that in relation to anxiety there are altered interoceptive states, where individuals show reduced ability to adequately report bottom-up interoceptive signals showing exaggerated response to these signals and typically experiencing them more aversive than they actually are (Paulus & Stein, 2010). This rely on more top-down cognitive-emotional processes is according to Paulus and Stein likely to result in maladaptive schemes of interpretation resulting that these individuals should perform more poorly on interoceptive tasks.

Limitations of the study

This study was part of the more extensive brain imaging study, resulting to relatively small sample size of 50. Compared to previous temperament and personality studies using various questionnaires the sample size is small, making generalizations of results less reliable. However, the sample size is around average when compared to other studies using heartbeat detection task. Also studies investigating the connection between interoceptive sensitivity and anxiety the sample sizes has varied from 16 to 90 participants (see overview of the studies by Domschke et al., 2010). Also the connections between interoceptive sensitivity, anxiety and temperamental variables were statistically significant.

In this study the participants were normal, healthy population, consisting mostly of university students and young adults which might have affected the results. It is possible that within healthy population the connection between interoceptive sensitivity and anxiety cannot be seen as strong as it would have been in a group consisting of clinical patients with more difficult symptoms. To study this, two groups should have been established.

The interoception measurement used in this study was measuring only interoceptive sensitivity. Interoceptive insight (metacognitive) or sensibility (self-evaluation) were not measured or included into analysis. It is possible that interoceptive sensitivity (accuracy measured by detection task) is not directly connected to anxiety, but interoceptive insight or sensibility might be, since they both involve subjective or more conscious experience. This might be a plausible explanation and it is shared by other researchers (Ehlers & Breuer, 1996; Garfinkel et al., 2015). An altered interoceptive prediction error signal might derive from discrepancy between the actual bodily signals and the subjective awareness or evaluation of these signals (Garfinkel et al., 2015). Sensibility involves cognitive

interpretation of interoceptive signals and misinterpretations might occur for anxiety-prone individuals, as was suggested in previous section.

One of the challenges of this study is related to the fact that the effect of temperament to psychological disorders, including anxiety, has been found to be mediated and moderated by a number of both internal and external factors (Rettew & McKee, 2005). Also the vast amount of different concepts and constructs related to temperament and versatile measurements makes it difficult to compare the results between different studies. However, it should be noted that in this study both trait anxiety (temperamental trait negative affect) and state anxiety (experience of anxiety measured by BAI) was studied in relation to interoceptive sensitivity and no connection was found between any of these anxiety variables and interoceptive sensitivity, suggesting more robust results.

Conclusion and further directions

Studies connecting various temperament traits and interoception are still scarce. This study is adding to this research tradition by investigating various temperament traits and their connections to interoceptive sensitivity and experience of anxiety. This study showed that temperament seems to have significant role in relation to both of them. Future research in this field is needed to further explain the connection and causality. Since only one temperament questionnaire was used to analyze the possible connections to interoception and anxiety, it would be interesting to investigate whether there are connections between various temperament and personality questionnaires or whether temperament instead of personality has stronger connection to interoceptive sensitivity due to its inherent nature. On the other hand, as some of the recent studies confirm, there have been found biological base for personality differences as well (Nigg, 2006). Comparing various questionnaires might confirm previously found connections between temperament and big 5 traits (Evans & Rothbart, 2007).

Research related to anxiety has demonstrated that cognitive factors play an important role in the development and maintenance of anxiety disorders but these factors possible effects on both anxiety and interoception was beyond this study. It can be argued that whether one is anxiety-prone seems not entirely related to any differences in interoceptive sensitivity, emotional reactiveness or self-regulation, but can be directed by more higher-order processing which in turn is most likely to be related to individual differences in this processing. In the future, it might be forth while to further investigate the higher-order processing of interoceptive information and its relation to temperamental differences.

The main result of this study suggests that high-anxiety individuals are not more sensitive to their interoceptive information than others. Hence, this study is in line with the current understanding that some mental health disorders such as anxiety disorders have a connection to misrepresented interoceptive signals or failure to anticipate changes in interoceptive states suggesting more attentional bias. Temperamental traits might be a potential background factor to this bias. This remains interesting research topic in the future.

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APPENDIX 1.

The Adult Temperament Questionnaire (ATQ)

The Adult Temperament Questionnaire (ATQ) was adapted from the Physiological Reactions Questionnaire developed by Derryberry and Rothbart (1988) and it includes general constructs of effortful control, negative affect, extraversion/surgency, and orienting sensitivity. The general constructs are referred to as factor scales and the sub-constructs are referred to as scales. The ATQ standard form includes 177 items and the short form 77 items. Both forms include the same constructs.

Hierarchical Listing of Scales

Factor scales listed in capital bold print. Scales listed in capital print.

NEGATIVE AFFECT

Fear: Negative affect related to anticipation of distress.

Sadness: Negative affect and lowered mood and energy related to exposure to suffering, disappointment, and object loss.

Discomfort: Negative affect related to sensory qualities of stimulation, including intensity, rate or complexity of visual, auditory, smell/taste, and tactile stimulation.

Frustration: Negative affect related to interruption of ongoing tasks or goal blocking.

EXTRAVERSION/SURGENCY

Sociability: Enjoyment derived from social interaction and being in the presence of others.

Positive Affect: Latency, threshold, intensity, duration, and frequency of experiencing pleasure.

High Intensity Pleasure: Pleasure related to situations involving high stimulus intensity, rate, complexity, novelty, and incongruity.

EFFORTFUL CONTROL

Attentional Control: Capacity to focus attention as well as to shift attention when desired.

Inhibitory Control: Capacity to suppress inappropriate approach behavior.

Activation Control: Capacity to perform an action when there is a strong tendency to avoid it.

ORIENTING SENSITIVITY

Neutral Perceptual Sensitivity: Detection of slight, low intensity stimuli from both within the body and the external environment.

Affective Perceptual Sensitivity: Spontaneous emotionally valenced, conscious cognition associated with low intensity stimuli.

Associative Sensitivity: Spontaneous cognitive content that is not related to standard associations with the environment.

Short form items by scales

Factor scales in capital and bold print, scales in bold print

NEGATIVE AFFECT

Fear

1. I become easily frightened.
12. Looking down at the ground from an extremely high place would make me feel uneasy.
22. When I am enclosed in small places such as an elevator, I feel uneasy.
51. Sometimes, I feel a sense of panic or terror for no apparent reason.
61. Loud noises sometimes scare me.
68R. It does not frighten me if I think that I am alone and suddenly discover someone close by.
75R. When I try something new, I am rarely concerned about the possibility of failing.

Frustration

6R. I rarely become annoyed when I have to wait in a slow moving line.
17. I find it very annoying when a store does not stock an item that I wish to buy.
31. Whenever I have to sit and wait for something (e.g. a waiting room), I become agitated.
38R. I am usually a patient person.
48. It doesn't take very much to make feel frustrated or irritated.
58R I usually remain calm without getting frustrated when things are not going smoothly for me.

Sadness

9R. I rarely feel sad after saying goodbye to friends or relatives.
20R. I seldom become sad when I watch a sad movie.
25. Sometimes minor events cause me to feel intense sadness.
34R. I seldom become sad when I hear of an unhappy event.
45. I sometimes feel sad for longer than an hour.
56. I often feel sad.
65. When I hear of an unhappy event, I immediately feel sad.

Discomfort

4. I find loud noises to be very irritating.
32. I'm often bothered by light that is too bright.
36. I find certain scratchy sounds very irritating.
42. Very bright colors sometimes bother me.
54. Colorful flashing lights bother me.
59. Loud music is unpleasant to me.

EFFORTFUL CONTROL

Activation Control

2R. I am often late for appointments.
8R. I often make plans that I do not follow through with.
15. I can keep performing a task even when I would rather not do it.
27. I can make myself work on a difficult task even when I don't feel like trying.
47. If I think of something that needs to be done, I usually get right to work on it.
55. I usually finish doing things before they are actually due (for example, paying bills, finishing homework, etc.).
72R. When I am afraid of how a situation might turn out, I usually avoid dealing with it.

Attentional Control

5R. It's often hard for me to alternate between two different tasks.
29R. When I am trying to focus my attention, I am easily distracted.
35. When interrupted or distracted, I usually can easily shift my attention back to whatever I was doing before.
40R. It is very hard for me to focus my attention when I am distressed.
50R. When I am happy and excited about an upcoming event, I have a hard time focusing my attention on tasks that require concentration.

Inhibitory Control

11. Even when I feel energized, I can usually sit still without much trouble if it's necessary.
26. It is easy for me to hold back my laughter in a situation when laughter wouldn't be appropriate.
43. I can easily resist talking out of turn, even when I'm excited and want to express an idea.
53R. I usually have trouble resisting my cravings for food drink, etc.
60R. When I'm excited about something, it's usually hard for me to resist jumping right into it before I've considered the possible consequences.
63R. When I see an attractive item in a store, it's usually very hard for me to resist buying it.
76. It is easy for me to inhibit fun behavior that would be inappropriate.

EXTRAVERSION/SURGENCY

Sociability

14R. I would not enjoy a job that involves socializing with the public.
19. I usually like to talk a lot.
37. I like conversations that include several people.
46R. I rarely enjoy socializing with large groups of people.
67. I usually like to spend my free time with people.

High Intensity Pleasure

7R. I would not enjoy the sensation of listening to loud music with a laser light show.
23. When listening to music, I usually like turn up the volume more than other people.
30. I would probably enjoy playing a challenging and fast paced video-game that makes lots of noise and has lots of flashing, bright lights.
44R. I would probably not enjoy a fast, wild carnival ride.
64. I would enjoy watching a laser show with lots of bright, colorful flashing lights.

73. I especially enjoy conversations where I am able to say things without thinking first.
77R. I would not enjoy the feeling that comes from yelling as loud as I can.

Positive Affect
3. Sometimes minor events cause me to feel intense happiness.
16R I sometimes seem to be unable to feel pleasure from events and activities that I should enjoy.
28. I rarely ever have days where I don't at least experience brief moments of intense happiness.
49. It doesn't take much to evoke a happy response in me.
70R It takes a lot to make me feel truly happy.

ORIENTING SENSITIVITY

Neutral Perceptual Sensitivity
10R. Barely noticeable visual details rarely catch my attention.
21. I'm often aware of the sounds of birds in my vicinity.
33R. I rarely notice the color of people's eyes.
52. I often notice mild odors and fragrances.
71R. I am rarely aware of the texture of things that I hold.

Affective Perceptual Sensitivity
13. When I am listening to music, I am usually aware of subtle emotional tones.
18. I tend to notice emotional aspects of paintings and pictures.
57. I am often aware how the color and lighting of a room affects my mood.
66R. When I watch a movie, I usually don't notice how the setting is used to convey the mood of the characters.
69. I am often consciously aware of how the weather seems to affect my mood.

Associative Sensitivity
24. I sometimes seem to understand things intuitively.
39. When I am resting with my eyes closed, I sometimes see visual images.
41. Sometimes my mind is full of a diverse array of loosely connected thoughts and images.
62. I sometimes dream of vivid, detailed settings that are unlike anything that I have experienced when awake.
74. Without applying effort creative ideas sometimes present themselves to me.

APPENDIX 2.

Beckin ahdistuskyselylomake (BAI)

Alla on lueteltu tuntemuksia, joita voi esiintyä silloin, kun ihminen on ahdistunut. Ympyröi numero sen mukaan, miten paljon tuntemus on rasittanut sinua kuluneen viikon aikana tämä päivä mukaan lukien.

	ei lainkaan	lievästi	kohtalaisesti (hyvin epämiellyttävä, mutta kestin sen)	vakavasti (niin vakavaa, että hädin tuskin kestin sen)
1. Puutuminen tai kihelmöinti	**0**	**1**	**2**	**3**
2. Kuuma olo (joka ei johdu lämpötilasta)	**0**	**1**	**2**	**3**
3. Heikotus jaloissa	**0**	**1**	**2**	**3**
4. Kyvyttömyys rentoutua	**0**	**1**	**2**	**3**
5. Pelko siitä, että pahin tapahtuu	**0**	**1**	**2**	**3**
6. Huimaus	**0**	**1**	**2**	**3**
7. Sydämentykytys	**0**	**1**	**2**	**3**
8. Tasapainohäiriöt	**0**	**1**	**2**	**3**
9. Kauhun tunne	**0**	**1**	**2**	**3**
10. Hermostuneisuus	**0**	**1**	**2**	**3**
11. Tukehtumisen tunne	**0**	**1**	**2**	**3**
12. Käsien vapina	**0**	**1**	**2**	**3**
13. Muu vapina	**0**	**1**	**2**	**3**
14. Itsehillinnän menettämisen pelko	**0**	**1**	**2**	**3**
15. Hengitysvaikeus	**0**	**1**	**2**	**3**
16. Kuolemanpelko	**0**	**1**	**2**	**3**
17. Yleinen pelokkuus	**0**	**1**	**2**	**3**
18. Ruoansulatusvaikeudet	**0**	**1**	**2**	**3**
19. Pyörtymisen pelko	**0**	**1**	**2**	**3**
20. Punastuminen	**0**	**1**	**2**	**3**
21. Hikoilu (joka ei johdu kuumuudesta)	**0**	**1**	**2**	**3**