Research Article

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Interoceptive accuracy does not predict emotion perception in daily life

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Abstract: Peripheral emotion theories suggest a crucial role of interoception for emotion perception, which in turn facilitates emotion regulation. Laboratory studies found positive relations between interoceptive accuracy and perceived emotion intensity and arousal. Studies in natural settings are largely missing, but seem important by virtue of emotional experience and regulation diversity.

On hundred seven participants underwent a cardiovascular interoceptive accuracy task. Afterwards, participants provided detailed information on perceived emotions and emotion regulation strategies in an ecological momentary assessment (EMA). Multilevel models were calculated. In consideration of valence, emotion intensity, arousal, intensity of body sensations and, emotion regulation success were modeled as a function of centered interoceptive accuracy.

Interoceptive accuracy did not predict any emotion perception criterion. Lower accuracy was related to a slightly stronger decrease of perceived arousal after regulation.

Differences in emotion categories, intensity, and sample collection might explain divergences to laboratory studies.

Keywords: interoception; heartbeat perception; emotion perception; emotion regulation; ecological momentary assessment.

1 Introduction

1.1 Theoretical models for the role of interoception in emotion perception

The idea that emotions are at least partially based on perceptions of bodily changes (e.g., James, 1884) is an integral part of embodied emotion theories (Gendron, 2009). Signals from the whole body, such as the face, the viscera, or even the posture are translated into emotional experience depending on the context (e.g., Flack, 2006). The ability to detect bodily signals or "interoceptive accuracy" (IA, see Garfinkel et al., 2015) may facilitate the perception of emotions and enhance the intensity in which emotions are perceived (Schandry, 1981).

In some theories, conscious emotion perception is thought to be based on the context-specific explanation of physiological arousal (i.e., the two-factor theory of emotion, for early studies see Cantril, 1932; Schachter & Singer, 1962). According to these theoretical frameworks, physical states of arousal are processed by the central nervous system and interpreted depending on the situation. For example, an accelerated heartbeat can be interpreted as anger when a person is in a conflict with another person or as joy when two people meet who are in love. Recently, it is also assumed that the brain already has hypotheses for physiological changes in specific (emotion eliciting) contexts and that these predictions are mapped against current physiological input at all levels of processing (Ainley et al., 2016). Information therefore flows simultaneously bottom-up (physiological afferents) and top-down (predictions of physiological afferents). Likely causes of physiological changes thus codify the perceived emotions (Seth, 2013). According to Ainley

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and colleagues (2016), people with high cardiac interoceptive accuracy (IAc) are able to optimize the precision of sensory signals by paying attention to the body. Identical bodily changes may lead to stronger emotional experience in people with high compared to low IAc (Ainley et al., 2016). Furthermore, predictions are updated more frequently and flexibly. As a result, both the experience of arousal changes and the allocation of arousal to a learned emotion are improved (Ainley et al., 2016). In other words, people with high interoceptive accuracy might be able to better use their bodily signals to interpret their emotions in different contexts.

Additionally, a better detection of arousal might also help to regulate emotional responses, e.g., by reducing the intensity of negative emotional experiences (Fustos et al., 2013). For example, clinical biofeedback research and practice is built on the notion that individuals who are more aware of their autonomic arousal are better able to control it (Pennebaker & Hoover, 1984). Some of the methods still in used today to capture interoceptive accuracy were developed based on this tradition (Pennebaker & Hoover, 1984). In line with findings that emotion differentiation is related to emotion regulation capacity (Barrett et al., 2001), we assumed that an increased ability to detect arousal changes and the flexible adaptation of predictions on them (Ainley et al., 2016) might also be helpful during emotion regulation.

1.2 Empirical findings on the relation between interoception and emotion perception and regulation

Though multiple bodily signals might serve to assess IA, i.e., skin conductance or muscle tension (e.g., Andor et al., 2008; Flor et al., 1992; Krautwurst et al., 2014), most researchers assess cardiac interoceptive accuracy (IAc). Heartbeats are internal events that can be assessed easily in terms of cost and time (Phillips et al., 1999). Since the inception of IAc assessment, there has been great interest in the relation of IAc with emotion perception (Katkin, 1985.; Schandry, 1981). Mental tracking paradigms have been most regularly used (e.g., Pollatos, Gramann, et al., 2007; Pollatos, Herbert, et al., 2007; Pollatos et al., 2005; Schandry, 1981). In mental tracking tasks, participants have to count their heartbeats during several time intervals of differing length. A higher correspondence of measured and counted heartbeats leads to higher IAc scores. Discrimination tasks are much less frequently adopted when examining the relation of IAc and emotion perception (e.g., Wiens et al., 2000). In a discrimination task, participants have to judge if a certain external signal is in or out of sync with their heartbeat. Typically, the signal is presented either at a time point in the cardiac cycle when most people sense their heartbeat or later in the cardiac cycle. Good heartbeat detectors are able to discriminate between both signals.

Emotion perception: In line with the model of Ainley and colleagues (2016), IAc is positively related to self-reported emotional arousal with medium to large effect sizes (Fustos et al., 2013; Herbert et al., 2010; Herbert et al., 2007; Katkin, 1985; Pollatos, Gramann, et al., 2007; Pollatos, Herbert, et al., 2007; Pollatos et al., 2005; Pollatos, Traut-Mattausch, et al., 2007). IAc was also reported to moderate the relation between actual heart rate changes and arousal ratings after pictoral emotion induction (Dunn et al., 2010). Similarly, emotional film clips were reported to induce more intense emotions in people with higher compared to lower IAc regardless of physiological arousal (Wiens et al., 2000).

Behavioral emotion induction tasks which are more closely related to the experience of emotions in everyday life (Wilhelm & Grossman, 2010) were used in addition to pictorial or cinematic emotion induction to assess the relation of IAc and emotion perception. In such behavioral emotion induction tasks (social) stressors are used to induce anxiety, embarrassment, frustration, or anger. Whereas non-social stressors include, for example, mental arithmetic tests that demand high workloads in short time spans, social stressors encompass performance tasks in front of an auditorium or games with social exclusion.

While high IAc was positively correlated with the intensity of negative emotions in two studies using non-social stressors (Kindermann & Werner, 2014a, 2014b), only one study with a small sample found a relation after social stress induction (Werner et al., 2009; Werner et al., 2013; Zamariola et al., 2019). Note that the heterogeneity of these results might be due to variation in the behavioral tasks or the general difficulty to reliably induce emotions with behavioral tasks in experimental settings.

Emotion regulation: Füstös and colleagues (2013) examined the relation of IAc and emotion regulation success based on their assumption that high sensitivity for bodily changes facilitates emotion regulation. In their study, participants were asked to either passively observe negative pictures or to downregulate their emotion by reappraising the shown content (for instance, by thinking about a positive outcome of the depicted scene). Afterwards, arousal and efficiency to downregulate elicited emotions were rated. IAc was positively related with arousal reduction after reappraisal compared to passive viewing and self-reported efficiency to downregulate the emotions (Fustos et al., 2013). Furthermore, a small positive association between IAc and the habitual use of reappraisal and emotion suppression was reported in another study (Kever et al., 2015). To the best of our knowledge, there have been no replications of these findings up to now.

1.3 Open questions and need of assessment in daily life

Several studies have investigated the relationship between emotion perception and IAc in laboratory settings (e.g., Herbert et al., 2011; Herbert et al., 2010; Herbert et al., 2007; Pollatos, Gramann, et al., 2007; Pollatos, Herbert, et al., 2007; Pollatos et al., 2005; Pollatos, Traut-Mattausch, et al., 2007). Studies on emotions in the laboratory provide reliable methods with high internal validity but low external validity. The richness of the emotional experience and emotion regulation strategies may be less well represented in laboratory settings. In contrast, ecological momentary assessment (EMA) allows understanding psychological phenomena with high ecological validity (Wilhelm & Grossman, 2010). Here, experiences are repeatedly sampled in the natural environment of participants at the time they occur (Stone & Shiffman, 1994). For instance, participants are prompted several times a day at random time points to report their current emotions and regulation strategies (e.g., Heiy & Cheavens, 2014; Trampe et al., 2015). EMA studies enable the examination of a broader range of emotions, emotion regulation strategies, and their fluctuations over a long time period (Heiy & Cheavens, 2014; Wilhelm & Grossman, 2010). Importantly, recent studies have shown that a broad range of emotions are perceived frequently and simultaneously in daily life (e.g. Trampe et al., 2015). Real-life situations were reported to elicit stronger physiological responses compared to laboratory emotion induction (Wilhelm & Grossman, 2010). In most emotion regulation studies in the laboratory, only few selected strategies were examined (i.e., reappraisal vs. emotion suppression); however, it has been shown that participants spontaneously use a broad variety of strategies once emotions are elicited (e.g., Aldao & Nolen-Hoeksema, 2013). For example, while being instructed to suppress eliciting emotions, a surprising amount of participants reported using cognitive emotion regulation during a laboratory study (60% in the case of a negative film clip and 70% in the case of a positive film clip Demaree et al., 2006). Furthermore, in natural settings, people might choose strategies that were not the object of investigation in laboratory experiments, such as situation selection (Wilhelm & Grossman, 2010). Participants of EMA studies can choose any adaptive response and do not have to remain as immobile as in laboratory settings (Wilhelm & Grossman, 2010). Instead, they can leave a certain situation, change their body posture or become active in various other ways. Thus, day-to-day investigations over long time intervals are needed to evaluate the validity of laboratory findings (Wilhelm & Grossman, 2010).

To date, only two studies have examined the relation of IAc and emotion perception in a natural setting. A positive relation of IAc and the ability to discriminate between low and high emotional arousal was reported (Study 1 and Study 2 of Feldman Barrett et al., 2004).

We aimed to investigate the relationship between interoception and emotion perception as well as emotion regulation in natural settings to substantiate laboratory findings. To the best of our knowledge, no study has combined emotion perception and regulation in natural settings and related these to IAc. We assumed that the emotion perception and regulation of our subjects would correspond to that of previous EMA studies on this topic (e.g., Trampe et al., 2015; Zelenski & Larsen, 2000). The predictive power of IAc for arousal, intensity of the emotion, intensity of bodily sensations during the emotion, pleasantness of the emotion and emotion regulation success was examined.

IAc was assumed to predict specifically emotional arousal, because laboratory evidence for this was strongest (e.g., Fustos et al., 2013; Herbert et al., 2011; Herbert et al., 2010; Herbert et al., 2007; Pollatos, Herbert, et al., 2007). We also assumed a close relationship of IAc and the perceived intensity of body sensation during emotions. Concerning emotion regulation, IAc was hypothesized to be positively related to emotion regulation success (i.e., maintenance of positive emotions and intensity/arousal, and reduction in the case of negative emotions).

2 Materials and Methods

2.1 Participants and procedure

We assessed a mainly collegiate sample of 107 volunteers (79 female, 28 male) aged between 18 and 45 years ($M = 23.51$, $SD = 3.84$). All volunteers underwent laboratory testing for approximately 60 minutes and an EMA assessment for seven consecutive days beginning the day after laboratory testing. Our study was designed and carried out in accordance with the recommendations of the Ethical Principles of Psychologists and Code of Conduct. Prior to testing, participants gave written informed consent in line with the Declaration of Helsinki. As assessed during a short screening, no participant suffered from an actual neurological, cardiovascular, or mental disorder; however, two participants reported having had one remitted mental disorder (anorexia nervosa, claustrophobia). Next, participants completed a demographic questionnaire and were introduced to the EMA survey. All participants practiced survey completion to ensure optimal compliance with the task. In addition, a written survey instruction was delivered to each participant. Afterwards, it was ensured that the survey ran properly on participants' mobile phone and the registration on the survey distribution website was completed. Subsequently, participants accomplished the mental tracking task. During the task, an electrocardiogram (ECG) was recorded. Three electrodes were fixed beyond the right/left clavicle and the left costal arch for this purpose. To present and analyze the ECG, we used Uvariotest (programmed by Gerhard Mutz; sampling was at 512 Hz). Biodata were recorded with the Varioport system (Becker Meditec, Germany). EMA assessment started one day after the laboratory testing. All participants were compensated monetarily or with credit points. Compensation was 40€/5 hours if participants completed at least 75% of delivered surveys and 20€/2.5 hours in all other cases.

2.2 Measurement of cardiac interoceptive accuracy

IAc was assessed with a mental tracking task (Schandry, 1981). Participants were instructed to silently count their heartbeats in three time intervals of various lengths by paying attention to body sensations that could be related to their heart activity. They were not allowed to feel their pulse or check their watch. The time intervals of 25, 35, and 45 seconds were presented in randomized order. A tone signaled the beginning and end of each interval. The duration of the intervals and whether their answers were correct was unknown to the participants.

2.3 Ecological momentary assessment of emotion perception and regulation

Daily surveys were implemented in Unipark (EFS Survey, Version 10.5, by Questback) and distributed as mobile phone text messages using hyperlinks via Survey Signal (SurveySignal©, 2015). Signals were sent six times per day for seven consecutive days between 9 am and 9 pm. Forty-two surveys were completed in the case of full compliance. Each day was divided in six two-hour time blocks, in which signals were sent at random time points. The minimum time interval between two signals was set to 60 minutes. One reminder signal was sent 15 minutes after the first signal in the case of no response. The survey link was disabled 45 minutes after forwarding the first signal. Average response time for one survey was 2.5 minutes. The survey started assessing participants' current mood (scroll bar ranging from 0 'very bad' to 100 'very well'). On scroll bars, participants indicated the intensity of 18 emotions (see supplement for the complete list of presented emotions; 7 emotions with positive valence; scale ranging from 0 'not present at all' to 6 'very intensive'). The actual emotions were assessed to compare everyday emotional experiences of the current EMA study with previous ones (e.g. Zelenski & Larsen, 2000). Specifically, we aimed to determine whether the emotional experience of our sample corresponded to that of participants from previous EMAs. Afterwards, the most intense emotion of the last hour had to be indicated. In order to ensure a balanced assessment of emotions with positive and negative valence, the survey referred to a negative *or* a positive emotion from this question forward. In half the surveys, participants were asked to indicate the most intense negative emotion, in the other half, they were asked to specify the most intensive positive emotion. We pseudo-randomized the order of presentation of the two valences twice. Two lists with different order of valence inquiry were generated (A, B). Three surveys with positive and three with negative valence were presented each day. Participants were randomly assigned to one of the two lists (53 participants underwent surveys in randomization A and 54 participants in randomization B). All subsequent questions referred to this emotion. Participants rated the *intensity* of this emotion (from 0 'not intense' to 6 'very intense') and indicated time of occurrence (minutes before the signal). They afterwards rated their *arousal* (from 0 'not at all' to 6 'very'), the *pleasantness* of the emotion (from –3 'very unpleasant' to +3 'very pleasant'), how strong they felt the emotion in their body (from 0 'not at all' to 6 'very'), and they evaluated how helpful the emotion was (from –3 'hindering' to +3 'helpful'). Among these ratings, intensity of emotion, arousal, pleasantness, and intensity of body sensations served as our indicators of emotion perception. Next, participants were asked to describe the way in which they dealt with the indicated emotion. Twenty-five strategies (23 of them concrete, one 'do nothing' and one 'do something else') were listed, allowing for multiple choices. Strategies were listed based on a previous EMA study on emotion regulation (Heiy & Cheavens, 2014) and adapted for the positive and negative valence of the emotions surveyed (a list of all strategies can be found in the Supplementary Material). Most of the strategies were assignable to one of the five sets that comprise the Gross process model of emotion regulation (Gross, 1998). Finally, participants again rated arousal, intensity, and pleasantness of the emotion (e.g., "How intense was the emotion in the end?").

2.4 Data analysis

2.4.1 Interoceptive accuracy

ECG data of all participants were screened for artifacts. IA was calculated by comparing measured and counted heartbeats. The scores obtained within three intervals were averaged. The heartbeat perception score (HBP score) was calculated as follows:

$$\text{HBP score} = 1 - 1/3\ \Sigma\ ((|\text{recorded heartbeats} - \text{counted heartbeats}|) / \text{recorded heartbeats}).$$

A perfect correspondence between the recorded and counted heartbeats resulted in a value of 1. Due to artifacts in the ECG signal, only two of three intervals were used to calculate the HBP score in one participant.

Emotion regulation success was calculated by subtracting post-regulation intensity, pleasantness, and arousal scores from the respective pre-regulation intensity, pleasantness, and arousal scores.

2.4.2 EMA data

Response rates were calculated for each participant to examine compliance and determine compensation. For descriptive purpose and to compare our data with other EMA studies on the experience of emotions and emotion regulation in natural settings, we calculated the average number of reported emotions, the occurrence of each single emotion, mean frequency, and intensity scores for the most intense positive and negative emotions, the number of selected and the relative frequency of each single emotion regulation strategy.

Next, we examined the predictability of emotion perception and emotion regulation success through IAc.

To account for the nested structure of our data (i.e., observations within participants), we used multilevel regression analyses. As we had several indicators of emotion perception and emotion regulation success (criterion variables), we ran several separate analyses, that is, one for each criterion. In all our multilevel models, *participant* was treated as a random effect, thus allowing intercepts to vary by participant. In a first step, we calculated a null-model for each criterion, with only the random effect but no fixed-effects (predictors). Intraclass correlations (ICC) were calculated from these null models, indicating the amount of variance in the criterion variable that is due to variability in participants. We then calculated a model with the fixed effect *valence* of the to-be-rated emotion (*valence model*; positive = 1; negative = –1). The slope for valence (level -1 predictor) was allowed to vary by participants (i.e., random slope). Next, to test the predictive power of IAc, we separately added IAc to the previously established *valence model* (the interaction between valence and the IAc was also included). All analyses were run in R (3.4.2) using the lme4 and lmerTest packages (Bates et al., 2015; Kuznetsova et al., 2017). Prior to analysis, data were prepared according to West, Aiken, & Krull (1996). IAc was grand-mean centered around zero. Valence was group-mean centered around zero. Unstructured covariance matrices and the Satterthwaite approximation for estimating degrees of freedom (lmerTest function) were used in all MLMs with criteria of interest.

Deviance tests were calculated to compare the incremental variance explanation of models of interest and valence models. Cross level interaction effects were tested with simple slope tests (Aiken & West, 1991). Effect sizes were estimated with semipartial R^2 (Edwards et al., 2008). Values for the calculation of semipartial R^2 were extracted with the lme function of the nlme package.

Estimation of power in multilevel models is rather complicated and depends on the level of predictors and their number, as well as intraclass correlations and estimated effects. Sample size at level 2 is more important than sample size of level 1 (Scherbaum & Ferreter, 2009). According to a simulation study, our level 1 and level 2 sample sizes should be sufficient to detect medium cross level interaction effects (Mathieu et al., 2012).

3 Results

3.1 Descriptives for cardiac interoceptive accuracy and emotions in daily life

Descriptives of interoception data and EMA response rates are displayed in Table 1.

Table 1: Descriptive statistics of interoceptive accuracy and response rates concerning ecological momentary assessment.

Variable / scale	Mean (Mdn.[1])	SD (IQR[1])	Min	Max
HR base[2]	77.95	10.73	58.57	114.63
HBP score	0.6	1.85	0.1	1.0
RR positive	20[1]	3[1]	2	21
RR negative	20[1]	3[1]	4	21
RR total	39[1]	4[1]	6	42

[2]N = 104; Abbreviations: HR = heart rate, HBP score = heartbeat perception score / IAc measure, RR = response rate

Concerning EMA data, frequency and intensity of positive emotions were higher compared to negative emotions. Positive emotions most often reported were satisfaction and happiness. Nervousness and irritability were most regularly mentioned as negative emotions. On average, participants applied about two strategies to regulate their most intense emotions, regardless of valence. No regulation strategy was reported in about one-quarter of assessments. Descriptive results indicate that no strategy was applied when intensity of emotions was lower. Situation selection and attention direction (participants reported to become active and pursue a (pleasing) activity) were most likely reported in reaction to negative emotions. Acceptance of and directing attention to the feeling were most commonly reported when positive emotions had been experienced. In general, when relating coping strategies to the process model of emotion regulation (Gross, 1998), participants most frequently used situation selection or modification and attention direction strategies as well as cognitive strategies. Response modulation, in contrast, was rarely used (see Supplementary Material for a more detailed description of EMA findings).

3.2 EMA - Relation between cardiac interoception and emotion

Contrary to our hypotheses, IAc did not predict any of our indicators of emotion perception significantly (all $p \geq 0.11$). Concerning emotion regulation success (difference scores), IAc was found to be a significant predictor of arousal regulation and pleasantness regulation, respectively. Specifically, lower cardiac accuracy was associated with stronger arousal regulation.

Table 2: Multilevel models with effect sizes for the predictors IAc, valence and their interaction.

Criterion (ICC)	Results						
	IAc (HBP)	R^2	Valence estimate	R^2	Interaction estimate	R^2	Modell (Chi^2(df))
emotion perception							
intensity of emotion (ICC = 0.15)	0.32	0.01	0.40***	0.02	0.05	<0.001	42.34(4)***
Arousal (ICC = 0.36)	0.75	0.02	0.16***	0.009	-0.05	<0.001	42.34(4)***
intensity of body sensation (ICC = 0.26)	0.45	0.01	0.15***	0.004	0.21	<0.001	127.61(4)***
pleasantness (ICC = 0.01)	0.17	0.01	0.35	0.004	0.15	<0.001	359.16(4)***
emotion regulation success							
arousal (ICC = 0.13)	0.45*	0.05	0.03	<0.01	0.15	<0.01	20.01(4)***
pleasantness (ICC = 0.01)	-0.15	0.03	-0.43***	<0.01	0.36**	<0.01	166.84(4)***

Abbreviations: ICC = intraclass correlation, HBP = heart beat perception score
'***' p<0.001, '**' p<0.01, '*' p<0.05, '.' p<0.1; R^2: > 0.02 'small', > 0.13 'medium', > 0.26 'large'

Simple slope tests revealed a negative effect of valence in low IAc ($b = -0.5$, $SE = 0.03$, $t(100.33) = -14.49$, $p < 0.001$) as well as high IAc ($b = -0.37$, $SE = 0.03$, $t(102.16) = -10.62$, $p < 0.001$). While there was no difference concerning IAc in the positive valence ($b = 0.17$, $SE = 0.26$, $t(59.98) = 0.64$, $p = 0.523$), a negative effect of IAc was found for the negative valence ($b = -0.94$, $SE = 0.23$, $t(39.83) = -4.12$, $p < 0.001$). In other words, an increase of pleasantness of negative emotions after emotion regulation was stronger in *low* compared to high IAc, where the slight reduction of pleasantness of positive emotions was similar in good and poor heartbeat perceivers.

4 Discussion

4.1 Emotion and emotion regulation in day-to-day life

Generally, our participants perceived and regulated their emotions comparably to samples of previous EMA assessments (e.g., Trampe et al., 2015; Zelenski & Larsen, 2000). Following these EMA studies, positive emotions were reported more often than negative ones (Trampe et al., 2015; Zelenski & Larsen, 2000). Subjects also reported experiencing multiple emotions simultaneously (see also Trampe et al., 2015). This may represent emotion perception more validly than laboratory studies. Alternatively, subjects may have named several emotions simultaneously, because they had difficulties differentiating among them. Although, in general, emotion experience was quite comparable to previous EMA studies, there were some differences concerning individual emotions. For example, frequency of enthusiasm was lower in our study compared to Zelenskis et al. (2000). This may be due to sampling characteristics like the number of days sampled and the amount of assessments per day (e.g. 3 days with 2 assessments in the study of Zelenskis and Larsen 2000), or the response format (a dichotomous one was used by Trampe and colleagues, 2015). In addition, our labeling and the inclusion of different emotions might have impacted findings with regard to the frequency of emotions being reported. For example, in our study, anxiety was reported less frequently (compared to Trampe et al., 2015; Zelenski & Larsen, 2000). However, participants of our study often experienced nervousness, a category clearly linked to the anxiety spectrum and not offered in the other two studies. The “most intense” positive and negative emotions were rated about one point higher in our study than the “currently experienced emotion” rated in the study by Zelenski & Larsen (2000).

On average, participants applied about two strategies to regulate their most intensive emotions, independent of valence. No regulation strategy was reported in about one-quarter of assessments. In contrast, participants of one previous EMA study reported applying seven (negative emotions) to eight (positive emotions) strategies in the majority of assessments (Heiy & Cheavens, 2014). This could be due to the fact that a longer time period was surveyed in that study. However, the range of strategies was quite comparable, with a clear priority for situation selection / modification and attention deployment in the present study. Additionally, participants reported cognitive change strategies relatively frequently. Body-focused muscle or breath relaxation was rarely selected. With the exception of response modulation strategies (i.e., emotion suppression, expression), participants reported using individual regulation strategies for positive and negative emotions comparatively often (see Supplementary Table 3). Moreover, the strategies most often used by the participants (e.g., savoring and behavioral activation in the case of positive emotions) were functional as they were shown to successfully improve mood in a previous study (Heiy & Cheavens, 2014).

4.2 Relation between cardiac interoceptive accuracy and emotion perception

Conversely to laboratory findings, IAc was unrelated to the perception of emotional arousal, bodily sensations during emotions, or pleasantness ratings. Valence, nature, and intensity of emotions, or sample characteristics might explain this contradictory set of findings.

It is very likely that the emotions elicited in the laboratory were markedly different from the emotions experienced by our participants in everyday life. In laboratory studies, mainly pictures of the International Affective Picture System (IAPS, Lang et al., 2008) are used to induce emotions. While three studies employed negatively valenced stimuli only (Fustos et al., 2013; Katkin, 1985; Pollatos, Traut-Mattausch, et al., 2007), all other studies elicited both positive and negative emotions (Dunn et al., 2010; Ferguson, 1996; Fustos et al., 2013; Herbert et al., 2010; Herbert et al., 2007; Pollatos, Gramann, et al., 2007; Pollatos, Herbert, et al., 2007; Pollatos et al., 2005). Attractive nudes or erotic couples were primarily used as positive stimuli (Herbert et al., 2010; Herbert et al., 2007; Pollatos et al., 2005). Sometimes, cute animals (Ferguson, 1996; Pollatos et al., 2005), humorous scenes (Ferguson, 1996), or foods and happy babies (Pollatos et al., 2005) were employed. Most positive IAPS pictures were reported to elicit amusement, awe, contentment, excitement, or blends of these emotions (Mikels et al., 2005). Amusement was reported relatively often in our study, but excitement not. Instead, our participants often perceived satisfaction and happiness as the most intense emotion. Negative IAPS pictures that induce sadness and disgust (Herbert et al., 2010) by depicting mutilations, injuries, or attacks were used most often in laboratory studies (Ferguson, 1996; Herbert et al., 2010; Herbert et al., 2007; Katkin, 1985; Pollatos et al., 2005). In our ecological assessment, these emotions were rarely reported as the most intensive negative emotion. In contrast, nervousness, irritability, and anger were much more common.

IAPS pictures elicit a typical triphasic heart period response with an initial deceleration followed by acceleration and a final deceleration of heart rate (Bradley et al., 2001; Paulus et al., 2016). People with higher IAc might be more sensible for these autonomic reactions and, consequently, rate themselves as more aroused compared to persons with lower IAc. Arguably, not all emotions are accompanied by such strong cardiovascular responses. For example, satisfaction might not coincide with strong cardiovascular reactions and consequently, may be relatively unrelated to cardiovascular sensitivity.

Most intense emotions were rated at about medium size intensity, whereas IAPS stimuli often induce emotions of higher intensity. Indeed, good heartbeat perceivers rated their arousal after IAPS picture watching in the upper-third of the self-assessment manikin rating scale (Herbert et al., 2010; Herbert et al., 2007). Alternatively, individuals might have better access to arousal changes while sitting still in a laboratory setting compared to being influenced by environmental changes in natural settings (Pennebaker, 1982).

IAc assessment of most laboratory emotion induction studies was similar to the current experiment following the procedure of Schandry (1981) and did not explain discrepancies in findings (only two studies used a discrimination task Ferguson, 1996; Katkin, 1985). However, HBP scores differed clearly from scores found in previous laboratory studies. While mean HBP scores ranged from .7 to .78 in many laboratory studies (Herbert et al., 2010; Herbert et al., 2007; Pollatos, Gramann, et al., 2007; Pollatos, Herbert, et al., 2007; Pollatos et al., 2005; Pollatos, Traut-Mattausch, et al., 2007), the present sample was characterized by an average score of .6 (comparable to Bornemann & Singer, 2017; Meyerholz et al., 2018). More participants with accurate heartbeat perception were included in laboratory studies (e.g., half the participants were accurate perceivers in some studies: Pollatos, Gramann, et al., 2007; Pollatos et al., 2005). Partially, volunteers were pre-screened to assure that half the sample comprisedd of accurate heartbeat perceivers (Pollatos, Herbert, et al., 2007). The Schandry task does not differentiate IAc in the case of medium or low perceptual sensitivity because, assumptions on heart rate confound the HBP score (Ring & Brener, 1996). Therefore, it might be easier to uncover relations when more participants with high IAc are included in studies. However, generalizability to the general population may be restricted as accurate heartbeat perceivers are clearly over-represented in these studies.

4.3 Relation of cardiac interoception and emotion regulation success

Emotion regulation success was not predicted by IAc in the hypothesized direction. Participants with high IAc perceived their arousal similarly before and after regulation. Although contradictory to our hypotheses, this can be understood if high IAc participants perceived their arousal to be more intense both before and after regulation. This would be the case if there was a significant relation between IAc and arousal *already before* emotion regulation. Indeed, the effect for the relation of IAc and arousal perception before regulation reached the size of a small effect, although it was not significant. Studies with larger sample sizes might have sufficient statistical power to detect such small effects. The body-oriented muscle and breath relaxation was rarely applied. To examine the impact of this strategy and the relation of this impact and cardiac sensitivity, future studies could use customized protocols. Nevertheless, associations between IAc and changes of emotion intensity, arousal, and pleasantness had been expected. Either there is no strong link between emotion regulation success and interoception, or our assessment was suboptimal. Perhaps the intensity of (at least negative) emotions was too low to capture emotion regulation when it is needed most. Possibly, the usage of difference scores was suboptimal, at least when the emotion appeared shortly before the signal was sent. In this case, more time might have been needed until strategies were fully effective. In addition, a self-reported impact of strategy application might have been useful (see Heiy & Cheavens, 2014). Finally, IAc might be relevant for usage of body-focused strategies only.

4.4 Limitations

Although EMA promises increased ecological validity, it is very difficult to survey all essential information when examining emotion perception and -regulation. We neglected to take emotion perception and regulation skills, contexts, or triggers into account, and, thus, did not capture social desirability or blended emotions. The assessment was too short to gain enough power to analyze individual emotions or selected emotion regulation strategies. A focus on the analysis of emotions that are accompanied by strong cardiovascular responses might have been advantageous to uncover relations with IAc. Future studies could implement event-based sampling instead of time-based sampling protocols to examine emotions with high intensities (Shiffman et al., 2008). An examination of temporal sequences also would be of great value concerning emotion regulation success. Trampe and colleagues (2015) performed network analyses to determine the centrality of specific emotions. Future studies could focus on central emotions - positive emotions that inhibit negative ones or negative emotions that inhibit positive ones - as these might be important targets of psychological interventions (Trampe et al., 2015). Concerning these emotions, future studies should examine impactful context-specific regulation strategies as important strategies are under-represented in emotion regulation research up to now (Heiy & Cheavens, 2014; Wilhelm & Grossman, 2010). There is a need for research on the maintenance of positive emotions to complement the research on efficient regulation of negative affect.

Finally, IAc assessment remains a challenge. Using mental tracking paradigms has been criticized for being confounded with expectations regarding one's own heart rate (Phillips et al., 1999; Ring & Brener, 1996; Ring et al., 2015). Signal detection paradigms that separate sensitivity from response strategies and have an appropriate level of difficulty should be implemented in future studies (Corneille et al., 2020; Pohl et al., 2021). Furthermore, cardiovascular accuracy might not be transferable to other relevant body domains. Indeed, the current state of research concerning the interrelation of sensitivity for different body domains is quite heterogeneous. Some studies found cross-modal relations (Tsakiris et al., 2011; Whitehead & Drescher, 1980) while, others did not (Garfinkel et al., 2016; Krautwurst et al., 2014; Krautwurst et al., 2016). Research on the relation of sensitivity for other body domains and emotion processing is urgently needed. For example, the relation between muscle tension and anger perception might be of interest. Finally, it would be interesting to assess the accuracy of perceived autonomic changes because these may be more closely related to emotions compared to heart rate at rest.

4.5 Conclusion

We show interrelations of cardiac interoception and emotion perception and regulation in natural settings that differ substantially from laboratory findings. Whether interoceptive accuracy is or is not an important basis for natural emotion processing is not finally clarified. Future research on interoception and emotion is needed and worthwhile as it might provide important information for psychopathological factors and psychological interventions.

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References

Aiken, L. S., & West, S. G. (1991). *Multiple Regression: Testing and Interpreting Interactions*. Sage.

Ainley, V., Apps, M. A., Fotopoulou, A., & Tsakiris, M. (2016). 'Bodily precision': a predictive coding account of individual differences in interoceptive accuracy. *Philos Trans R Soc Lond B Biol Sci*, *371*(1708). https://doi.org/10.1098/rstb.2016.0003

Aldao, A., & Nolen-Hoeksema, S. (2013). One versus many: Capturing the use of multiple emotion regulation strategies in response to an emotion-eliciting stimulus. *Cognition & Emotion*, *27*(4), 753-760. https://doi.org/10.1080/02699931.2012.739998

Andor, T., Gerlach, A. L., & Rist, F. (2008). Superior perception of phasic physiological arousal and the detrimental consequences of the conviction to be aroused on worrying and metacognitions in GAD. *J Abnorm Psychol*, *117*(1), 193-205. https://doi.org/10.1037/0021-843X.117.1.193

Barrett, L. F., Gross, J., Christensen, T. C., & Benvenuto, M. (2001). Knowing what you're feeling and knowing what to do about it: Mapping the relation between emotion differentiation and emotion regulation. *Cognition & Emotion*, *15*(6), 713-724. https://doi.org/Doi 10.1080/02699930143000239

Bates, D., Machler, M., Bolker, B. M., & Walker, S. C. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1), 1-48. <Go to ISI>://WOS:000365981400001

Bornemann, B., & Singer, T. (2017). Taking time to feel our body: Steady increases in heartbeat perception accuracy and decreases in alexithymia over 9 months of contemplative mental training. *Psychophysiology*, *54*(3), 469-482. https://doi.org/10.1111/psyp.12790

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and Motivation I: Defensive and Appetitive Reactions in Picture Processing [Article]. *Emotion*, *1*(3), 276-298. https://doi.org/10.1037//1528-3542.1.3.276

Cantril, H. H., W.A. (1932). Emotional Effects Produced by the Injection of Adrenalin *The American Journal of Psychology*, *44*(2), 300-307.

Corneille, O., Desmedt, O., Zamariola, G., Luminet, O., & Maurage, P. (2020). A heartfelt response to Zimprich et al. (2020), and Ainley et al. (2020)'s commentaries: Acknowledging issues with the HCT would benefit interoception research. *Biol Psychol*, *152*. https://doi.org/10.1016/j.biopsycho.2020.107869

Demaree, H. A., Robinson, J. L., Pu, J., & Allen, J. J. B. (2006). Strategies actually employed during response-focused emotion regulation research: Affective and physiological consequences. *Cognition & Emotion*, *20*(8), 1248-1260. https://doi.org/10.1080/02699930500405303

Dunn, B. D., Galton, H. C., Morgan, R., Evans, D., Oliver, C., Meyer, M., Cusack, R., Lawrence, A. D., & Dalgleish, T. (2010). Listening to your heart. How interoception shapes emotion experience and intuitive decision making. *Psychol Sci*, *21*(12), 1835-1844. https://doi.org/10.1177/0956797610389191

Edwards, L. J., Muller, K. E., Wolfinger, R. D., Qaqish, B. F., & Schabenberger, O. (2008). An R-2 statistic for fixed effects in the linear mixed model. *Statistics in Medicine*, *27*(29), 6137-6157. https://doi.org/10.1002/sim.3429

Feldman Barrett, L., Quigley, K. S., Bliss-Moreau, E., & Aronson, K. R. (2004). Interoceptive Sensitivity and Self-Reports of Emotional Experience. *Journal of Personality and Social Psychology*, *87*(5), 684-697.

Ferguson, M. L. K., E.S. . (1996). Visceral perception, anhedonia, and emotion. *Biol Psychol*, *42*, 131-145.

Flack, W. F. (2006). Peripheral feedback effects of facial expressions, bodily postures, and vocal expressions on emotional feelings. *Cognition & Emotion*, *20*(2), 177-195. https://doi.org/10.1080/02699930500359617

Flor, H., Schugens, M. M., & Birbaumer, N. (1992). Discrimination of Muscle Tension in Chronic Pain Patients and Healthy Controls. *Biofeedback and Self-Regulation*, *17*(3), 165-177. https://doi.org/Doi 10.1007/Bf01000401

Fustos, J., Gramann, K., Herbert, B. M., & Pollatos, O. (2013). On the embodiment of emotion regulation: interoceptive awareness facilitates reappraisal. *Soc Cogn Affect Neurosci*, *8*(8), 911-917. https://doi.org/10.1093/scan/nss089

Garfinkel, S. N., Manassei, M. F., Hamilton-Fletcher, G., den Bosch, Y. I., Critchley, H. D., & Engels, M. (2016). Interoceptive dimensions across cardiac and respiratory axes. *Philosophical Transactions of the Royal Society B-Biological Sciences*, *371*(1708). https://doi.org/10.1098/rstb.2016.0014

Garfinkel, S. N., Seth, A. K., Barrett, A. B., Suzuki, K., & Critchley, H. D. (2015). Knowing your own heart: Distinguishing interoceptive accuracy from interoceptive awareness. *Biol Psychol*, *104*, 65-74. https://doi.org/10.1016/j.biopsycho.2014.11.004

Gendron, M. F. B., L. (2009). Reconstructing the Past: A Century of Ideas About Emotion in Psychology. *Emotion Review*, *1*(4), 316-339. https://doi.org/10.1177/1754073909338877

Gross, J. J. (1998). The Emerging Field of Emotion Regulation: An Integrative Review. *Review of General Psychology*, *2*(3), 271-299. https://doi.org/10.1037/1089-2680.2.3.271

Heiy, J. E., & Cheavens, J. S. (2014). Back to basics: a naturalistic assessment of the experience and regulation of emotion. *Emotion*, *14*(5), 878-891. https://doi.org/10.1037/a0037231

Herbert, B. M., Herbert, C., & Pollatos, O. (2011). On the Relationship Between Interoceptive Awareness and Alexithymia: Is Interoceptive Awareness Related to Emotional Awareness? *Journal of Personality*, *79*(5), 1149-1175. https://doi.org/10.1111/j.1467-6494.2011.00717.x

Herbert, B. M., Pollatos, O., Flor, H., Enck, P., & Schandry, R. (2010). Cardiac awareness and autonomic cardiac reactivity during emotional picture viewing and mental stress. *Psychophysiology*, *47*(2), 342-354. https://doi.org/10.1111/j.1469-8986.2009.00931.x

Herbert, B. M., Pollatos, O., & Schandry, R. (2007). Interoceptive sensitivity and emotion processing: an EEG study. *Int J Psychophysiol*, *65*(3), 214-227. https://doi.org/10.1016/j.ijpsycho.2007.04.007

James. (1884). What is an Emotion? *Mind*, *9*(34), 188-205.

Katkin, E. S. (1985). Blood, Sweat, and Tears: Individual Differences in Autonomic Self-Perception. *Psychophysiology*, *22*(2), 125-137.

Kever, A., Pollatos, O., Vermeulen, N., & Grynberg, D. (2015). Interoceptive sensitivity facilitates both antecedent- and response-focused emotion regulation strategies. *Personality and Individual Differences*, *87*, 20-23. https://doi.org/10.1016/j.paid.2015.07.014

Kindermann, N. K., & Werner, N. S. (2014a). Cardiac Perception Enhances Stress Experience. *Journal of Psychophysiology*, *28*(4), 225-232. https://doi.org/10.1027/0269-8803/a000114

Kindermann, N. K., & Werner, N. S. (2014b). The impact of cardiac perception on emotion experience and cognitive performance under mental stress. *J Behav Med*, *37*(6), 1145-1154. https://doi.org/10.1007/s10865-014-9564-7

Krautwurst, S., Gerlach, A. L., Gomille, L., Hiller, W., & Witthoft, M. (2014). Health anxiety - An indicator of higher interoceptive sensitivity? *J Behav Ther Exp Psychiatry*, *45*(2), 303-309. https://doi.org/10.1016/j.jbtep.2014.02.001

Krautwurst, S., Gerlach, A. L., & Witthoft, M. (2016). Interoception in Pathological Health Anxiety. *J Abnorm Psychol*, *125*(8), 1179-1184. https://doi.org/10.1037/abn0000210

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, *82*(13), 1-26. <Go to ISI>://WOS:000417711600001

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International Affective Picture System (IAPS): Instruction manual and affective ratings, Technical Report A-8*. University of Florida.

Mathieu, J. E., Aguinis, H., Culpepper, S. A., & Chen, G. (2012). Understanding and Estimating the Power to Detect Cross-Level Interaction Effects in Multilevel Modeling. *Journal of Applied Psychology*, *97*(5), 951-966. https://doi.org/10.1037/a0028380

Meyerholz, L., Irzinger, J., Witthoft, M., Gerlach, A. L., & Pohl, A. (2018). Contingent biofeedback outperforms other methods to enhance the accuracy of cardiac interoception: A comparison of short interventions. *J Behav Ther Exp Psychiatry*, *63*, 12-20. https://doi.org/10.1016/j.jbtep.2018.12.002

Mikels, J. A., Fredrickson, B. L., Larkin, G. R., Lindberg, C. M., Maglio, S. J., & Reuter-Lorenz, P. A. (2005). Emotional category data on images from the International Affective Picture System. *Behav Res Methods*, *37*(4), 626-630. https://www.ncbi.nlm.nih.gov/pubmed/16629294

Paulus, P. C., Castegnetti, G., & Bach, D. R. (2016). Modeling event-related heart period responses [Article]. *Psychophysiology*, *53*(6), 837-846. https://doi.org/10.1111/psyp.12622

Pennebaker, J. W. (1982). Perceptual Processes I: Competition of Cues. In *The Psychology of Physical Symptoms*. Springer.

Pennebaker, J. W., & Hoover, C. W. (1984). Visceral Perception Versus Visceral Detection - Disentangling Methods and Assumptions. *Biofeedback and Self-Regulation*, *9*(3), 339-352. https://doi.org/Doi 10.1007/Bf00998977

Phillips, G. C., Jones, G. E., Rieger, E. J., & Snell, J. B. (1999). Effects of the presentation of false heart-rate feedback on the performance of two common heartbeat-detection tasks. *Psychophysiology*, *36*(4), 504-510. https://doi.org/Doi 10.1017/S0048577299980071

Pohl, A., Hums, A. C., Kraft, G., Koteles, F., Gerlach, A. L., & Witthoft, M. (2021). Cardiac interoception: A novel signal detection approach and relations to somatic symptom distress. *Psychol Assess*. https://doi.org/10.1037/pas0001012

Pollatos, O., Gramann, K., & Schandry, R. (2007). Neural systems connecting interoceptive awareness and feelings. *Hum Brain Mapp*, *28*(1), 9-18. https://doi.org/10.1002/hbm.20258

Pollatos, O., Herbert, B. M., Matthias, E., & Schandry, R. (2007). Heart rate response after emotional picture presentation is modulated by interoceptive awareness. *Int J Psychophysiol*, *63*(1), 117-124. https://doi.org/10.1016/j.ijpsycho.2006.09.003

Pollatos, O., Kirsch, W., & Schandry, R. (2005). On the relationship between interoceptive awareness, emotional experience, and brain processes. *Brain Res Cogn Brain Res*, *25*(3), 948-962. https://doi.org/10.1016/j.cogbrainres.2005.09.019

Pollatos, O., Traut-Mattausch, E., Schroeder, H., & Schandry, R. (2007). Interoceptive awareness mediates the relationship between anxiety and the intensity of unpleasant feelings. *J Anxiety Disord*, *21*(7), 931-943. https://doi.org/10.1016/j.janxdis.2006.12.004

Ring, C., & Brener, J. (1996). Influence of beliefs about heart rate and actual heart rate on heartbeat counting. *Psychophysiology*, *33*(5), 541-546. https://doi.org/DOI 10.1111/j.1469-8986.1996.tb02430.x

Ring, C., Brener, J., Knapp, K., & Mailloux, J. (2015). Effects of heartbeat feedback on beliefs about heart rate and heartbeat counting: A cautionary tale about interoceptive awareness. *Biol Psychol*, *104*, 193-198. https://doi.org/10.1016/j.biopsycho.2014.12.010

Schachter, S., & Singer, J. E. (1962). Cognitive, Social, and Physiological Determinants of Emotional State. *Psychological Review*, *69*(5), 379-399. https://doi.org/DOI 10.1037/h0046234

Schandry, R. (1981). Heart Beat Perception and Emotional Experience. *Psychophysiology*, *18*(4), 483-488. https://doi.org/DOI 10.1111/j.1469-8986.1981.tb02486.x

Scherbaum, C. A., & Ferreter, J. M. (2009). Estimating Statistical Power and Required Sample Sizes for Organizational Research Using Multilevel Modeling. *Organizational Research Methods*, *12*(2), 347-367. https://doi.org/10.1177/1094428107308906

Seth, A. K. (2013). Interoceptive inference, emotion, and the embodied self. *Trends Cogn Sci*, *17*(11), 565-573. https://doi.org/10.1016/j.tics.2013.09.007

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological Momentary Assessment. *Annual Review of Clinical Psychology*, *4*(1), 1-32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Stone, A. A., & Shiffman, S. (1994). Ecological momentary assessment (EMA) in behavorial medicine. *Annals of Behavioral Medicine*, *16*(3), 199-202. https://doi.org/10.1093/abm/16.3.199

Trampe, D., Quoidbach, J., & Taquet, M. (2015). Emotions in Everyday Life. *PLoS One*, *10*(12), e0145450. https://doi.org/10.1371/journal.pone.0145450

Tsakiris, M., Tajadura-Jimenez, A., & Costantini, M. (2011). Just a heartbeat away from one's body: interoceptive sensitivity predicts malleability of body-representations. *Proceedings of the Royal Society B-Biological Sciences*, *278*(1717), 2470-2476. https://doi.org/10.1098/rspb.2010.2547

Werner, N. S., Duschek, S., Mattern, M., & Schandry, R. (2009). Interoceptive Sensitivity Modulates Anxiety During Public Speaking. *Journal of Psychophysiology*, *23*(2), 85-94. https://doi.org/10.1027/0269-8803.23.2.85

Werner, N. S., Kerschreiter, R., Kindermann, N. K., & Duschek, S. (2013). Interoceptive Awareness as a Moderator of Affective Responses to Social Exclusion. *Journal of Psychophysiology*, *27*(1), 39-50. https://doi.org/10.1027/0269-8803/a000086

West, S. G., Aiken, L. S., & Krull, J. L. (1996). Experimental personality designs: Analyzing categorical by continuous variable interactions. *Journal of Personality*, *64*(1), 1-48. https://doi.org/DOI 10.1111/j.1467-6494.1996.tb00813.x

Whitehead, W. E., & Drescher, V. M. (1980). Perception of Gastric Contractions and Self-Control of Gastric-Motility. *Psychophysiology*, *17*(6), 552-558. https://doi.org/DOI 10.1111/j.1469-8986.1980.tb02296.x

Wiens, S., Mezzacappa, E. S., & Katkin, E. S. (2000). Heartbeat detection and the experience of emotions. *Cognition & Emotion*, *14*(3), 417-427. https://doi.org/Doi 10.1080/026999300378905

Wilhelm, F. H., & Grossman, P. (2010). Emotions beyond the laboratory: theoretical fundaments, study design, and analytic strategies for advanced ambulatory assessment. *Biol Psychol*, *84*(3), 552-569. https://doi.org/10.1016/j.biopsycho.2010.01.017

Zamariola, G., Luminet, O., Mierop, A., & Corneille, O. (2019). Does it help to feel your body? Evidence is inconclusive that interoceptive accuracy and sensibility help cope with negative experiences. *Cognition and Emotion*, *33*(8), 1627-1638. https://doi.org/10.1080/02699931.2019.1591345

Zelenski, J. M., & Larsen, R. J. (2000). The distribution of basic emotions in everyday life: A state and trait perspective from experience sampling data. *Journal of Research in Personality*, *34*(2), 178-197. https://doi.org/DOI 10.1006/jrpe.1999.2275