



“And how did that make you feel?” – Repeated symptom queries enhance symptom reports elicited by negative affect

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ABSTRACT

Objective: Negative affect, alexithymia, and other predisposing traits (such as health anxiety) can influence an individual's symptom perception. In this study, we used the affective picture paradigm (APP, Bogaerts et al., 2010) to induce symptoms using affective picture stimuli. We aimed to cross-sectionally test the effect of high vs low-frequency symptom queries and analyze the time course of the APP, including interactions with health anxiety and somatic symptom distress.

Methods: Participants ($N = 124$) completed a modified APP and filled out various questionnaires. In the APP, participants were randomized to either a highly-frequent-query condition (18 symptom checklists) or a less-frequent-query condition (6 checklists). Data were analyzed using ANOVAs, cross-lagged panel models, moderation models, and multilevel models.

Results: Both groups had comparable symptom baseline values, but people in the highly frequent as opposed to less frequent condition reported significantly higher symptom levels once the experiment started ($F(1,120) = 14.319, p < .001, \eta^2 = .107$). Symptom levels stayed stable over the course of the experiment and were best predicted by symptom levels at earlier timepoints in the experiment ($\beta = 0.43$ and $\beta = 0.68$, both $p < .001$). Health anxiety levels significantly predicted symptom levels ($F(1,121) = 10.054, p = .002, \eta^2 = .077$) and moderated the relation between condition and symptom levels ($F(2,121) = 16.253, p < .001, \eta^2 = .212$).

Conclusion: In terms of the predictive processing model (e.g., [1]), repeated symptom queries following negative affective cues may activate prior beliefs about symptoms, resulting in elevated levels of symptom reports in interaction with health anxiety.

Persistent somatic symptoms (PSS), meaning “subjectively distressing somatic complaints, irrespective of their etiology” [2], present a large public health burden. Around 2/3 of symptoms in primary care have no clear underlying cause [3], which leads to a large associated healthcare cost [4]. Next to the sensory processing aspect of symptoms, PSS typically consist of a cognitive-emotional component [5,6], such as excessive thoughts or worries about the symptoms (see also the definition of a somatic symptom disorder, [7]). If individuals additionally show high health anxiety, they are likely to selectively allocate their attention to potential health threats [8–12] and thus are more likely to report somatic symptoms [13].

The mechanisms and etiology of PSS remain unclear. Interoception, the process of perceiving and processing bodily signals [14], is

considered an important process in the development of PSS. Interoceptive accuracy, meaning how accurately an individual perceives bodily signals, was originally postulated to be higher in people with PSS [15–17]. More recent research has shown the opposite – people with PSS are less accurate at perceiving actual bodily sensations [6,18,19], but report paying more attention to their bodies (interoceptive attention; [18,20,21]). Previous experience and expectations can heavily impact the perception of bodily changes [22–24]. This is in line with the Predictive Processing Model [1,25,26], which states that symptom experience results from the interplay between actual physiological input and predictions generated by the brain (so-called ‘prior’), both weighted by their relative precision (or reliability). If a person has strong (precise) priors representing expectations about bodily symptoms combined with

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low precise somatic input, their overall symptom experience will be dominated by the prior rather than by the actual physiological input. In summary, the predictive processing model sees an experienced symptom as resulting from an active construction process by the brain in which top-down factors such as attention and expectancies play a crucial role.

One important variable associated with elevated symptom reports is trait and state negative affect [11,27]. On the one hand, multiple unpleasant symptoms can lead to higher level of negative affect. On the other hand, Bogaerts et al. [28] found that viewing negative affective pictures can elicit elevated symptom reports in a laboratory setting. This effect was especially pronounced in high habitual symptom reporters [28,29], including patients with functional somatic syndromes [30]. The more negative the pictures were perceived, the more participants reported symptoms, although physiological markers of arousal (e.g., skin conductance, heart rate) were not elevated [31]. People with difficulties identifying feelings (as measured by the Toronto Alexithymia Scale) showed a more enhanced effect [30,32], but labelling affective states could counteract the symptom enhancing effect [33]. Recent studies suggest that the relationship between difficulties identifying feelings and symptom perception is mediated by experiential avoidance [34,35]. Both somatosensory and nociceptive brain activation patterns mediated the symptoms elicited by viewing negative affective pictures [36].

Earlier diary studies observed that asking participants to report symptoms more frequently resulted in higher symptom frequencies and intensities being reported [37,38]. In accordance with a predictive processing account (but also with more traditional cognitive concepts, such as accessibility and availability of information), these data suggest that the experience of symptoms might be enhanced through the combined effect of presenting negative affective cues together with repeated queries about symptoms. If these queries activate symptom priors while the actual physiological signal remains vague, symptom priors will dominate the construction process by the brain resulting in the experience of a symptom. Consequently, we wanted to test whether stronger activation of symptom priors would elevate symptom reports in the APP. In the present study, we therefore investigated the effects of repeated symptom queries, assuming that more frequent queries would enhance the effect of symptom priors.

By modifying the APP to have a ‘high frequency’ and a ‘low frequency’ query condition while keeping the exposure duration the same in both conditions, we investigated whether asking people about their symptoms at different frequencies would enhance symptom reporting in the APP. We were also interested in how preexisting symptom burden, alexithymia, and health anxiety would influence the relation between query frequency and symptom reporting. Preexisting symptom burden was expected to be positively associated with symptom reporting, and even more so in the highly frequent (as opposed to less frequent) query condition. Because health anxiety is associated with preexisting symptom burden, we hypothesized it would be a moderator between query frequency and symptom reporting.¹ In line with earlier findings, difficulties identifying feelings, a subfactor of alexithymia, was predicted to mediate between preexisting symptom burden and symptom reporting in the APP.

1. Methods

1.1. Transparency and openness

This study's design and analysis plan are preregistered at <https://aspredicted.org/b6ac4.pdf>. We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study, and

¹ We pre-registered quite concrete hypotheses. Given the available evidence [2,39–43], which points to a more complex relationship between these constructs, we realize that an exploratory approach might have been more reasonable here.

we follow JARS [44]. Data and code are available at <https://osf.io/vjqbp/>. All non-physical materials are publicly available. Data were analyzed using only the tools and programs listed below.

We obtained ethical approval in accordance with the 7th revision of the Helsinki Declaration from the local ethics commission.

1.2. Participants

G*Power was used to determine the required sample size [45]. For 80% power, $\alpha = 0.05$, and a medium-sized effect, $N = 128$ persons would be needed, but because of anticipated dropouts in the online setting, we planned to overrecruit until we reached $N = 150$. We recruited participants via student mailing lists, the survey-sharing platform SurveyCircle, and through social media. Participants were eligible if they were between 18 and 70 years old and had sufficient German skills. Participants were compensated with course credits and we additionally donated 1€ per participant to Doctors Without Borders. The recruitment period was 03/08/2023 to 04/05/2023.

1.3. Materials

1.3.1. Questionnaire measures

Patient Health Questionnaire – 15 (PHQ-15). We used this questionnaire [46] to measure pre-existing symptom burden in the past 4 weeks. It spans 15 items (focussing on somatic complaints such as stomach pain, headache, fainting spells) that are rated on a scale of 0 (*not bothered at all*) to 2 (*bothered a lot*). The PHQ-15 is reliable and has been validated in several settings [46,47]. The German version of the PHQ-15 was translated by Löwe [48]. In our study, the internal consistency was $\alpha = .72$.

Health Anxiety Inventory (HAI). This inventory, which was originally developed by Salkovskis et al. [49], measures health-related concerns. We used the shortened German version [50], which comprises 14 items that are responded to on a 5-point scale (0 = *strongly agree*, 4 = *strongly disagree*). In our sample, $\alpha = .94$.

Toronto Alexithymia Scale (TAS-20). This instrument for assessing deficiencies in recognizing and describing emotions was developed by Bagby, Parker, and Taylor [51]. Responses to the 20 items are given on a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*). The instrument is grouped into 3 subscales: Difficulty Identifying Feelings, Difficulty Describing Feelings, and Externally Oriented Thinking. The TAS-20 has successfully been validated [51,52], also in German [53]. We measured $\alpha = .90$.

1.3.2. Affective picture paradigm (APP)

The APP is an experimental paradigm used to investigate the influence of affective stimuli on symptom reporting [28]. Different versions of the task exist [29,31,54], but all use negative affective pictures as stimuli and at least one control condition (neutral and/or positive pictures), followed by some form of state symptom assessment and a valence/arousal measure. In this study, we used 108 pictures from the International Affective Picture System (IAPS, [55]), which were presented for 7 s each. For valence and arousal, we used the Self-Assessment Manikin (SAM, [56]), and for symptoms, we used a short version of the Checklist Symptoms Daily life – state version (CSD, originally by Wientjes & Grossman [57], validated in German by Sauer & Witthöft [58]). This shortened version consisted of 12 items with the largest differences in symptom reporting between negative and neutral pictures in an earlier study [54].

The task consisted of 18 picture-viewing blocks, half of which contained negatively valent picture stimuli. The other half consisted of neutral picture stimuli. Negative and neutral blocks were alternated and the starting condition was randomly assigned. Before viewing the first block, participants filled out the CSD and the SAM as a baseline assessment.

Participants were randomly assigned to one of two conditions: the

'highly frequent queries' (HF) condition or the 'low frequent queries' (LF) assessment condition. In the LF condition, participants filled out the checklist and SAM after every third block, which amounted to 6 CSDs and SAMs in total. In the HF condition, participants received the checklist and SAM after every block, so 18 assessments in total. See also Fig. 1.

1.3.3. Design and procedure

This study uses a cross-sectional design.

Upon clicking the link to the study, participants were informed about the study and then asked to give informed consent. After screening for age eligibility, participants were then redirected to Inquisit web [59], the platform hosting the experimental task. After this task, participants were asked to provide demographic information (gender, education, occupation), to report about the presence of functional syndromes, and to fill in the above-mentioned questionnaires. We included attention checks (e.g., "Please tick the leftmost box") in the survey to ensure data quality.

1.4. Statistical analysis

Data were analyzed using SPSS Version 27 [60] and R version 4.3.1 [61]. We used the PROCESS macro for moderations and mediations [62]. In R, we used packages foreign, psych, ggplot2, lme4, lmerTest, data.table, and lavaan [63–68].

We created 'difference' variables (negative minus neutral blocks) for valence, arousal, and symptom reporting. We calculated these difference variables for the total experimental task, as well as for early, mid, and late timepoints. 'Early' signifies the difference between the third and sixth block (one of which is negative and the other is neutral), 'mid' the difference between 9th and 12th block, and 'late' the difference between 15th and 18th block. Note that these are the timepoints where participants from both the high and low frequency condition are assessed concerning their valence, arousal, and state symptom reports in the CSD.

We used t-tests to check for successful randomization and manipulation. After that, ANOVAs were used to check the effects of start order (negative, neutral) and frequency condition on overall arousal differences, valence differences, and symptom differences. Next, we looked at timepoint-specific effects of frequency condition and preexisting symptom burden on difference effects of valence, symptoms, and arousal. Correlational analyses were used to test associations between APP effect and trait measures. Our moderation and mediation hypotheses were tested using Baron and Kenny's rules [69] with 5000 bootstrap samples. Multilevel models were used to examine the time-effect over the course

of the blocks for arousal (SAM), valence (SAM), and state symptom reporting (CSD) in both negative and neutral conditions. For variables where a linear effect of time was detected, we built increasingly complex models (as outlined in [70]) until we reached conditional growth models with random slopes and intercepts for the PHQ-15 total score. Using a model-comparison function (anova() from the 'stats' package in R), we sequentially tested models against each other to determine which model had the best fit.

Finally, cross-lagged panel models were used to explore the relations between valence differences, arousal differences, and symptom differences at early, mid, and late timepoints.

2. Results

2.1. Demographic data

We registered N = 149 people who completed the entire survey. Of these, n = 11 failed an attention check, n = 13 did not have complete experimental data, and n = 1 completed the study twice, so only their first participation was used. Our final dataset therefore consisted of N = 124 persons. Because the programming required answers to be given to continue to the next questionnaire or task, there was no missing data. Table 1 shows the demographic data in detail.

2.2. Effects of frequency condition

For symptom difference across the entire experiment, frequency condition had a significant effect. People in the HF condition reported significantly more symptoms in negative vs. neutral blocks as compared to people in the LF query condition ($F_{total}(3, 120) = 4.988, p = .003, \eta^2 = .111; F_{cond}(1, 120) = 14.319, p < .001, \eta^2 = .107$). This was also the case for valence: people in the HF condition found negative vs. neutral significantly more unpleasant than people in the LF query condition ($F_{total}(3, 120) = 6.969, p < .001, \eta^2 = .148; F_{cond}(1, 120) = 18.249, p < .001, \eta^2 = .132$). The negative vs. neutral comparison of arousal also showed a significant condition effect, but the total model was not significant ($F_{total}(3, 120) = 2.240, p = .087, \eta^2 = .053; F_{cond}(1, 120) = 5.878, p = .01, \eta^2 = .047$). Starting order, or the interaction of starting order and frequency, did not have any significant effects.

We conducted repeated measures ANOVAs to better understand the influence of condition and preexisting symptom burden on individual timepoints (early, mid, late). The effects (negative minus neutral trials) of arousal and symptoms did not change over timepoints; there was some indication that valence slightly changed. Frequency condition was

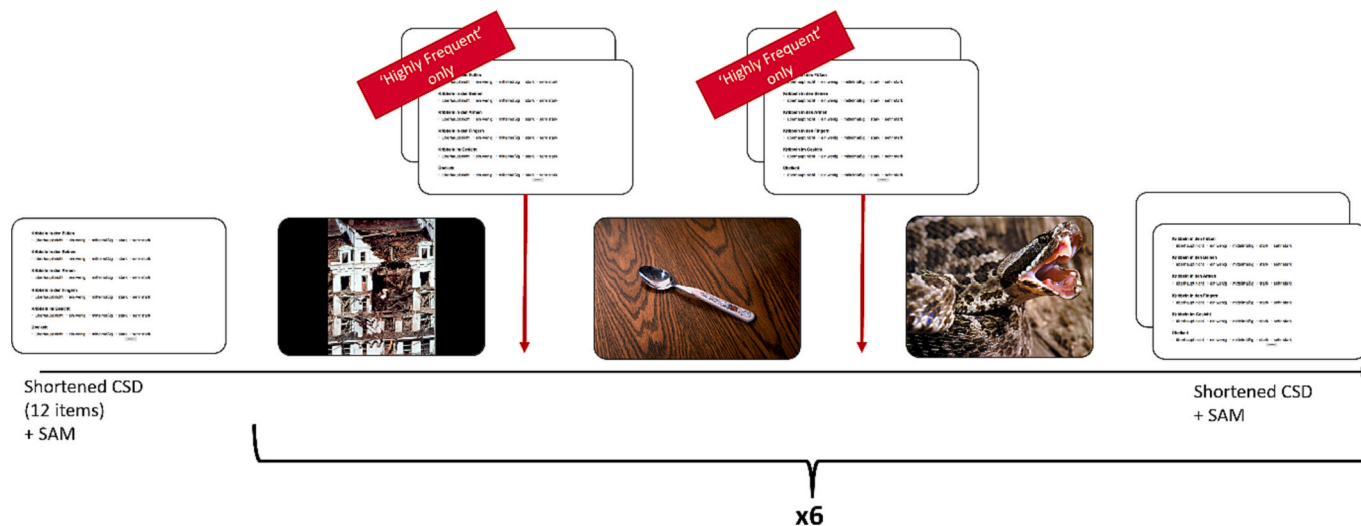


Fig. 1. Procedure of the Affective Picture Paradigm in this Study.

Table 1
Demographic data.

	M or n (%)
Participants (female/male/non-binary)	124 (98/25/1)
Age (SD)	27.4 (8.9)
Occupation	
Apprentice	2 (1.6%)
Student	88 (71.0%)
Employed	21 (16.9%)
Civil Servant	3 (2.4%)
Self-employed	5 (4.0%)
Unemployed, job seeking, or homemaker	4 (3.2%)
Other	1 (0.8%)
Education	
University degree	69 (55.6%)
Tertiary entrance degree	42 (33.9%)
Restricted tertiary entrance degree	4 (3.2%)
Completed trade apprenticeship	8 (6.5%)
Mid-level school diploma	1 (0.8%)
Self-reported functional syndrome	
Irritable Bowel	8 (6.5%)
Fibromyalgia	1 (0.8%)
Tension Headache	15 (12.1%)
Chronic Fatigue	2 (1.6%)
Tinnitus	9 (7.3%)
Chronic back pain	7 (5.6%)
Premenstrual Syndrome	9 (7.3%)

Note. We acknowledge that the term “chronic back pain” comprises heterogeneous syndromes and that not all forms of chronic back pain are functional. More detailed questions would be necessary to assess the type of pain correctly.

significant across all tests: People in the LF condition reported less symptoms/arousal and more valence than people in the HF condition. Preexisting symptom burden was significant for symptoms, but not

valence and arousal. See Supplement A for exact values.

The differences between negative and neutral blocks across timepoints are summarized in Fig. 2.

2.3. Moderation and mediation models

Frequency condition significantly moderated between pre-existing symptom burden and symptom effect in the APP, i.e., people in the HF query condition had a higher APP effect (CSD-diff score) at the same PHQ-15 scores. Difficulties identifying feelings did not significantly mediate the relationship between the PHQ-15 and the APP effect (CSD-diff score). Health anxiety significantly moderated the relation between frequency condition and the APP effect. This indicates that, at the same levels of health anxiety, people in the HF condition reported more symptoms in the negative (vs. neutral) condition than people in LF condition. Lastly, health anxiety did not significantly moderate the relation between PHQ-15 and APP effect (CSD-diff score).

As an exploratory analysis, we investigated whether health anxiety moderated the frequency effect at early, mid, and late timepoints using a repeated measures ANOVA. There were significant main effects of health anxiety and frequency condition. The within-person effects of timepoint and its interactions were not significant, but health anxiety and frequency condition had a significant interaction, indicating that people with more health anxiety in the higher frequency condition reported relatively more symptoms.

See Supplement B for values and more information.

2.4. Cross-lagged panel model

We fitted a cross-lagged panel model to the data to examine the relations between arousal difference, valence difference, and symptom

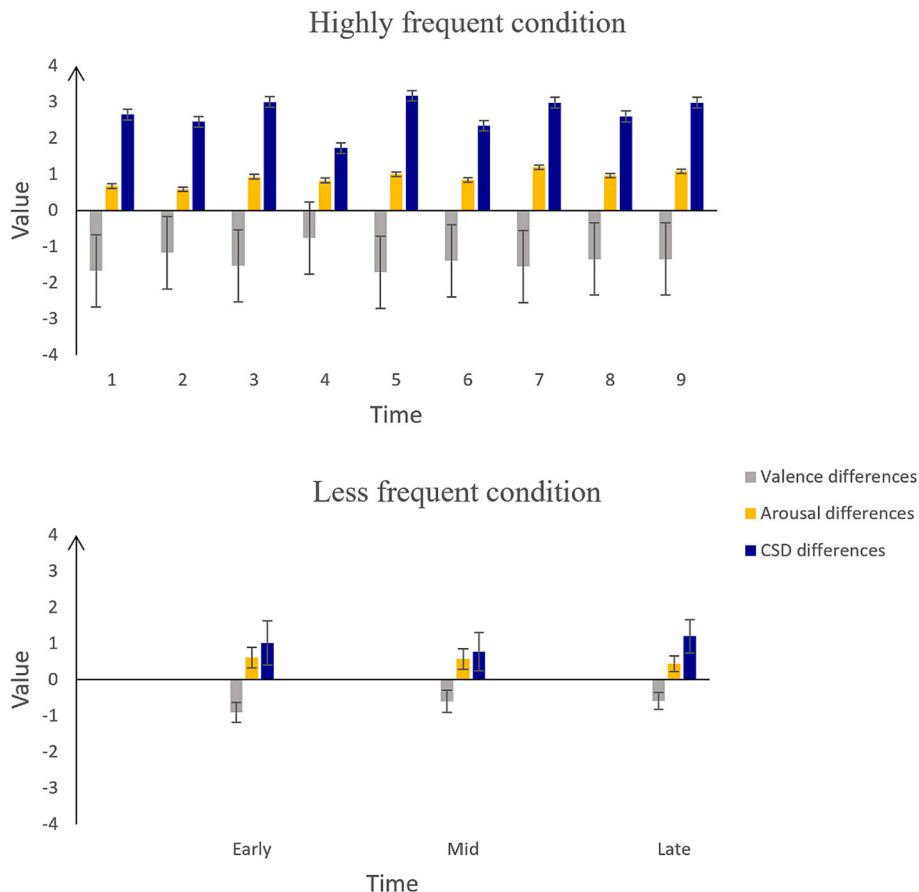


Fig. 2. Symptom, Valence, and Arousal Differences Between Negative and Neutral Images in the HF vs. LF Condition.

reporting difference at early, mid, and late timepoints.

The model had a good fit. Note that arousal always significantly predicted valence, but not vice versa. Symptom differences were always significantly related to valence and arousal but were best predicted by symptom differences in earlier trials. See Supplement C for exact values and Fig. 3 for a graphic representation.

2.5. Additional analyses

The results of randomization and manipulation checks and correlational analyses can be found in Supplements D and E. We conducted multilevel models to check the effects of time course, but only found slight effects for valence and arousal after neutral trials (See Supplement F).

3. Discussion

The goal of this study was to examine how the frequency of symptom queries influences somatic symptom reports as elicited by negative picture viewing. Next to frequency, we examined the influence of pre-existing symptom burden, difficulties identifying feelings, and health anxiety on symptom reports in the APP.

Our main finding is that people in the HF condition reported higher symptom levels than people in the LF condition, and that this difference is, surprisingly, already visible at the ‘early’ timepoint (after 6 picture series) with no changes over the later course of the study. Currently why this happened already at such an early timepoint is unclear, and future research should disambiguate this finding. Note that both groups reported the same levels of experienced valence, arousal, and symptom levels on the CSD at the beginning of the experiment. As people in the HF condition were prompted 18 times about their symptoms, there was a longer timespan between the queries for people in the LF condition (6 prompts), so they might have experienced an active downregulation (e.g., through distraction or reappraisal) or passive decrease of symptom experience. People in the frequent picture condition, on the other hand, might even have been reinforced to monitor their symptoms non-stop as they were able to anticipate that they would be asked about their symptoms again very soon. The symptom queries therefore may act as a continuous activation of symptom priors (or cognitive schema).

In earlier studies, state negative affect and arousal was significantly associated with symptom reports [31,54]; however, the exact temporal and causal relationship between subjective valence, subjective arousal, and symptom reports remains unclear. By using cross-lagged panel models, we were able to examine the interplay between these three variables. In line with earlier findings, these models indicate that valence does not influence later symptoms – but neither does arousal. Instead, earlier symptom effects best predict later symptom effects and

additionally also bring about later arousal. More research is needed to solidify this finding, but if this is indeed true, this is an interesting contrast to the traditional understanding of somatic symptoms pioneered by James, Lange, and later Damasio [71,72]. According to these authors, physiological signals or arousal would come first in a chain of events, followed by an interpretation or appraisal (creating the experience of a symptom) later.

As hypothesized, PHQ-15 levels were associated with symptom reporting in the APP. In contrast to our expectations and earlier findings [30,54], we were not able to show that difficulties identifying feelings were associated with APP effects. Only PHQ-15 scores were correlated with the TAS-DIF subscale. The lack of significant effect may stem from too little variance in this non-clinical sample, or a too small sample size to detect small effects.

Regarding our last group of hypotheses, we found that health anxiety was associated with symptoms after negative pictures and symptom difference scores. Also, the relationship between health anxiety and symptom reporting was moderated by frequency condition: People in the HF condition reported more symptoms in the APP than people in the LF condition at the same levels of health anxiety. This is in line with earlier findings that people with higher health anxiety are more likely to allocate their interoceptive attention to potential health threats [9–11]. Here, it seems that health anxiety acts as a prior and can have interactive effects with other factors that keep priors activated, such as the query frequency.

These findings fit to the predictive processing and the Better Safe than Sorry models [11,26], the latter of which posits that ambiguous bodily signals are more likely to be classified as potentially threatening symptoms because it is cognitively more resourceful to use this heuristic than to remain uncertain about the nature of a signal. In this case, the prior is the cocktail of negative affect and more frequent queries – in combination, these two factors are a catalyst for somatic symptom experience (the posterior), while each on its own do not have such consequences. Since there is little to no physiological somatic input during this experiment, we can conclude that the symptom experience is dominated by the prior. Discrediting priors is more difficult when they are constantly reactivated, or, in the wording of the Better Safe than Sorry model, minimizing errors is harder when there is no change to how the brain samples sensory input or without the possibility to create new sensory input [11,68].

Understanding the effects of assessment frequency has implications for healthcare workers working with patients with and without PSS as it would help them strike the balance between asking enough to get a full picture of a patient's complaints, but not asking too often to induce symptoms by activating priors and worsen a patients' condition. Physicians meet patients in situations of bodily changes that can lead to sampling more information and forming new priors [73], such as after a

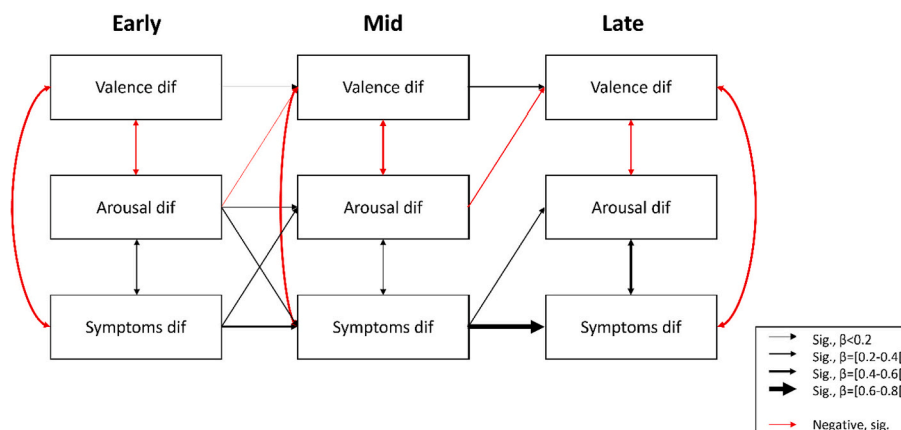


Fig. 3. Cross-Lagged Panel Model with Valence, Arousal, and Symptom Differences.

surgery or in the postpartum period. Physician behavior can influence the formation of new priors, and this research indicates that constantly asking patients about symptoms may not be a good strategy, especially if these symptoms are unspecific. We suggest using open questions (e.g., “What can I do for you today?” vs. “How has your urinary tract infection been going?”), avoiding symptom checklists and instead using empathetic listening strategies, and encouraging patients to reach out when ‘something changes’ regarding their symptoms or wellbeing [37,38].

This setup, a blocked version of the APP with two experimental conditions administered with participants in a non-clinical setting, is the first of its kind. A limitation of our research is that we did not have access to medical records to verify whether the participants had functional or other disorders or diseases. Also, our sample consisted mostly of students and is therefore not very heterogeneous. Nevertheless, with 35 people with a self-reported functional syndrome and 42 people above the PHQ-15 = 10 cutoff, we argue that there was a broad range and good representation of people with various preexisting symptom levels. Our experimental setup was geared towards members of the general population and we do not make conclusions about clinical manifestations of functional disorders. Therefore, we think our results have good generalizability.

In conclusion, this study shows that the frequency of assessing symptoms can intensify the symptom experience. Following the predictive processing and active inference framework [1,25], this is likely attributable to stronger attention allocation to symptom priors, thereby increasing their precision. Having an already higher preexisting symptom burden or health anxiety predispose an individual to be more affected by this symptom-intensification process. For experiencing symptoms, our findings underline the importance of the prior, which can be sharpened by making it more precise.

CRedit authorship contribution statement

Tara M. Petzke: Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Lina Elspaß:** Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ferenc Köteles:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Omer Van den Bergh:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Michael Witthöft:** Writing – review & editing, Supervision, Resources, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpsychores.2024.111634>.

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