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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 46(0)

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Publication Date
2024

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Predisposed Mood and Music in Perceptual Judgement Task

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Abstract

The current study examines the interaction between predisposed mood, perceptual processing, and induced mood using music. We conducted an experiment in which participants were asked to identify stimuli at global or local (G/L) perceptual levels with four different background music conditions, which had different valence and arousal ratings. We used BMIS to assess current mood and PHQ-9 and GAD-7 to assess depression and anxiety, and divided the participants into two groups: distress and no distress (encompassing both disorders). We found a main effect of background music on mood. However, the distress group showed an overall low mood. Further, we observed an overarching effect of predisposed mood, encompassing depression and anxiety, on individuals' transient mood experience and perceptual task performance. Individuals in the non-distress group showed a larger global-precedence effect. The results are discussed in light of emotional reactivity theories and the theory of positive emotion.

Keywords: Depression, anxiety, perceptual level processing, music, mood induction.

Introduction

Depression or major depressive disorder (MDD) is characterized primarily by the persistent sad mood and loss of interest/ pleasure in everyday activities (anhedonia) (Beck, 2002). It is also associated with deficits and changes in multiple cognitive domains like attention, perception, memory, executive functions and processing of emotionally valence stimuli (Fossati, 2018; Sinha, Arora, Srivastava, & Klein, 2022). The current study investigates the relationship between depression, affective state, and perception.

Studies (Sheoran & Srivastava, 2022; Bylsma, Morris, & Rottenberg, 2008) investigating the effect of depression on emotional experience have shown mixed results (Sinha et al., 2022; Bylsma et al., 2008).The emotional reactivity theory (Rottenberg, Gross, & Gotlib, 2005) states that individuals with distress conditions may respond to affective stimuli differently than those in the non-distress group. While consistent observation involves, reduced positive emotional reactivity to pleasant stimuli, especially widely reported finding (Bylsma et al., 2008; Sheoran & Srivastava, 2022), response to negative or sad stimuli presents conflicting result (Rottenberg et al., 2005). Such conflicts may stem from differences in sample profile (Bylsma et al., 2008), methodology (Sheoran & Srivastava, 2022), stimuli (Sheoran & Srivastava, 2022; Sinha et al., 2022) or heterogenous nature of the depression state.

Among various methods, music stands out as a widely accepted method to induce mood and relieve individuals grappling with depression (Garren & Van Buskirk, 2021). The widespread adoption of music in our daily lives is evident in a study revealing that, on average, adults listen to approximately 18 hours of music every week (Greasley & Lamont, 2011). Not only do we use music to engage directly, but we also use it in the background while performing daily chores, class routines, office work, dining, etc, which presents its prevalence and pervasiveness.

Unlike controlled lab studies, where foreground music is used for a specific mood induction (Kenealy, 1988; Västfjäll, 2001; Campbell, Berezina, & Gill, 2021) to examine its impact on cognitive task performance, our everyday music encounters predominantly involve background music, and only a few study have examined its impact on mood and cognitive task performances (Jolij & Meurs, 2011; Phillips, 2004). The effect of background music can be observed on recall and memory (Nguyen & Grahn, 2017), selective attention (Nadon, Tillmann, Saj, & Gosselin, 2021), computer-mediated problem-solving tasks (Phillips, 2004), and visual perception (Jolij & Meurs, 2011). In sum, these findings suggest that music not only induces mood but also affect cognitive task performances.

Given that depression is a mood or affective disorder, investigation of potential mood change due to background stimuli appears appealing. Such a study will help to understand the relationship between depression and transitory mood change and, in turn, their impact on everyday task performance.

Theory of positive emotion (Fredrickson, 2000, 2004) elucidates the different cognitive responses associated with induced or predisposed mood. It has been argued that pleasant mood broadens the scope of attention, whereas unpleasant mood narrows the scope of attention (Fredrickson, 2004). The broadening of attention entails increased sensitivity towards the wider array of information in the environment, whereas the narrowing results in a smaller focus of attention filtering out the surroundings (Fredrickson, 2000, 2004; Wadlinger & Isaacowitz, 2006). However, some studies have shown contradictory results (Wang, Chen, & Zhang, 2018; von Mühlenen, Bellaera, Singh, & Srinivasan, 2018).

Recently, a study (Wang et al., 2018) reported a distinct effect of varying levels of induced sadness on attentional pro-

In L. K. Samuelson, S. L. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), *Proceedings of the 46th Annual Conference of the Cognitive Science Society.* ©2024 The Author(s). This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

cessing using Navon stimuli. They observed better global processing with a low level of sadness and better local processing with a high level of sadness. The authors argued that a low level of sadness increases the scope of attention and facilitates global processing, whereas as the sadness increases, it narrows the scope of attention and therefore facilitates local processing (Wang et al., 2018). It is noteworthy that sadness may not comprise a unitary response (Wang et al., 2018). The levels of sadness may determine the scope of attention, and so as the related cognitive processes. Such findings have paramount importance to the predisposed mood or mood disorder, such as depression and anxiety. How does the individuals' self-reported depressive and anxious state in the presence of induced mood affect perceptual level processing?

In a nutshell, music is associated with individual mood and cognitive task performance. However, the intricacies of the interaction between music and mood and cognitive task performance in the context of predisposed mood remain unclear. Following are few questions we aim to address in the current article. How does music influence mood when played in the background while performing a perceptual-level judgement task? How does this background music interact with individuals' predisposed moods, like persistent sadness or depression? How does background music and depression/anxiety influence cognitive task performance, like a perceptual-level judgment?

To address the aforementioned questions, we have the following hypothesis: *a*. If background music successfully induces mood, then we expect a more pleasant mood experience with high-valence background music as compared to low valence background music. However, the magnitude of induction may be subject to the individual's predisposed mood state. *b*. We expect a strong effect of predisposition on background music and interaction of induced mood with predisposed mood on perceptual task performance.

Materials and Methods

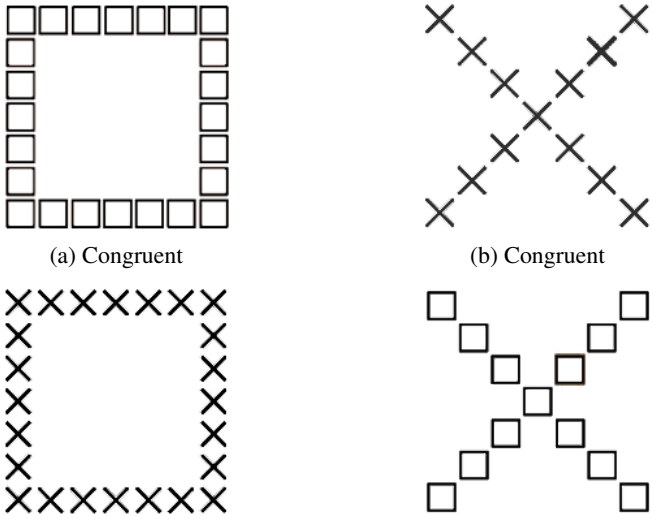
Participants

A total of 93 university students or interns (31 females, 62 males; 0 others; age range = 18-31 years, M= 21.17, SD=2.10) volunteered for the study. We recruited the participants via email, social media, or snowball sampling method. All participants reported normal or corrected to normal vision. Participants were presented with an online consent form outlining the study materials, experimental procedures, potential comfort and discomfort, rights to withdraw from the study, and data privacy.

Stimuli and Materials

We used Navon compound stimuli to investigate global/local perceptual level processing, and unpleasant and pleasant music in the background to investigate the impact of transitory mood on perceptual level judgment task performance.The immediate mood was assessed using BMIS (Brief Mood Introspection Scale) after every type of background music was played. Participants' predisposed mood state was measured using self-reported surveys, Patient Health Questionnaire (PHQ - 9) for depression, Generalized Anixety Disorder Assessment (GAD - 7) for anxiety, Perceived Stress Scale (PSS - 10) for stress and State Trait Anxiety Inventory - Trait (STAI-T) for trait anxiety. The details of each material is described below:

Navon Stimuli The target was a hierarchical Navon-like figure (Navon, 1977; Caparos, Linnell, Bremner, de Fockert, & Davidoff, 2013) and was chosen from a predefined set (Figure 1). Every image uses an elemental shape, "cross" or "square", equally spaced to form a larger figure (Figure 1). The elemental shape is the local feature and the larger figure is the global feature. The predefined set has 2 congruent images (Figure 1a and 1b), having the same global and local feature and 2 incongruent images (Figure 1c and 1d), having different global and local features.



(a) Congruent (b) Congruent

(c) Incongruent (d) Incongruent

Figure 1: The set of target figures with global and local features

Music Stimuli The sequence of target figures was accompanied by one of the four selected background musical tracks taken from the soundtrack dataset (Eerola & Vuoskoski, 2011), which contained valence-arousal ratings for approximately 110 tracks. We opted for a track from each quadrant on the valence-arousal graph to ensure consistency among participants. For each quadrant, we determined the 50th percentile values for both valence and arousal individually. We extracted the music tracks that exceeded the individual 50th percentile threshold for both, their valence and arousal values. From the extracted tracks, we randomly selected one track for each quadrant. Consequently, we obtained a track for each condition: HVHA, HVLA, LVHA, and LVLA. In this context, HV represents high valence, LV signifies low valence, HA denotes high arousal, and LA signifies low arousal.

Psychological Health Questionnaire The following questionnaires were used in the experiment:

- Patient Health Questionnaire (PHQ-9) (Kroenke, Spitzer, & Williams, 2001) is a brief 9-item questionnaire designed to assess depressive symptoms experienced by individuals in the two weeks prior to the date of assessment using a 4 point Likert scale where 0 = not at all and 3 = nearly every day. Total score range from 0 to 27, with a score of 10 or above indicating moderate to severe level of depression (Kroenke & Spitzer, 2002).

- Generalized Anxiety Disorder (GAD-7) (Spitzer, Kroenke, Williams, & Löwe, 2006) is designed to assess the general anxiety of the participants over the last two weeks from the date of assessment using a 4 point Likert scale where 0 = not at all and 3 = nearly every day. The total score ranges from 0 to 21. Similar to PHQ - 9, scores above 10 are indicative of moderate to severe anxiety levels.(Kroenke, Spitzer, Williams, Monahan, & Löwe, 2007).

- Perceived Stress Scale (PSS-10) (Cohen, Kamarck, Mermelstein, et al., 1994) is a widely used tool to measure the degree of stress in the participants' life over the last month from the date of assessment using a 5 point Likert scale where 0 = never and 4 = very often. The total score can range from 0 to 40 with higher scores indicating higher levels of stress.

- State Trait Anxiety Inventory - Trait (STAI-T) (Spielberger, Gonzalez-Reigosa, Martinez-Urrutia, Natalicio, & Natalicio, 1971) is a widely used tool to measure the state and trait anxiety using a 4 point Likert scale where 1 = almost never and 3 = almost always. We incorporate only the trait anxiety questionnaire in our study.

- Brief Mood Introspection Scale (BMIS) (Mayer & Gaschke, 1988) helps us assess the immediate mood as opposed to the ones mentioned earlier which measure the predisposed state. This uses a 4 point Likert scale for different emotions felt where 0 = Definitely do not feel and 3 = Definitely feel.

Equipment details

The experiment was presented on a 24-in LCD monitor, kept at a viewing distance of 70cm. The target figure was presented equally often at a visual angle of 1.5° above and below the centre of the screen. The participants were also provided with a chin-rest to keep their head steady while performing the task and wore headphones which were provided to them. This was performed in a closed room. The experiment was built using PsyToolkit (Stoet, 2010, 2017). It was downloaded and run offline using a self-written python script to avoid any issues which occurred on the web interface of PsyToolkit as the experiment was long and took approximately 30 minutes to complete.

Task and measures

The participants were asked to perform the following major tasks: (1) Navon Task in presence of background music, (2) BMIS and background music track rating, (3) Mental health questionnaire: GAD, PHQ, PSS, STATI-T. The flow of the experiment is shown in Figure 2.

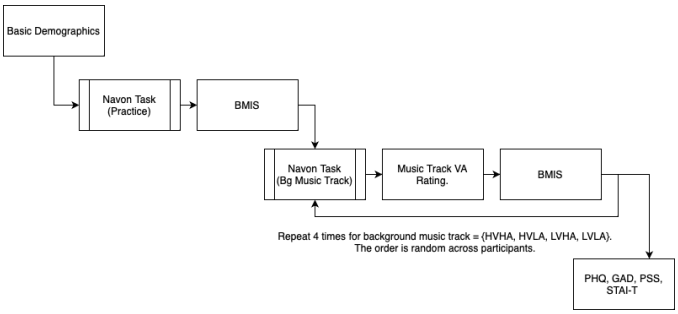


Figure 2: Experiment flow chart

Navon Task For every trial, participants were asked to look at a centre cross which was presented for 1000ms. A blank screen followed for 500ms and then the stimuli flashed for 250ms after which the participants had to press the right arrow key on the keyboard for "square" and left arrow key for "cross". If there is no key press, the trial would time out in 2000ms and proceed to the next trial. The participant performed two tasks. In the global task (Caparos et al., 2013), participants were asked to ignore the local feature and identify the global feature. In the local task (Caparos et al., 2013), participants were asked to ignore the global feature and identify the local feature.

Each task had 40 trials, where all the stimuli (Figure 1) occurred equally often. The two tasks together formed a Navon Task block and they occurred in a random order in a block. There were four such blocks, each block comprised of a pleasant or unpleasant music with high or low arousal level. The experiment started with a practice Navon Task block which had 8 trials for each task where the arrow key press was followed by a correctness feedback. The tasks had detailed instructions with pictorial representations. The main Navon Task block was repeated 4 times under the 4 different background music tracks. The order was counter balanced among participants. Every task in the main block also started with a practice of 4 trials to get acquainted with the task and avoid confusion between the global and local tasks.

BMIS and background music track rating After completion of each Navon Task block, the participant were asked to fill the BMIS questionnaire. The immediate mood of the participant was assessed by the pleasant-unpleasant score of BMIS using the subtractive scoring method(Mayer & Cavallaro, 2019). The participants also rated the background music for the given Navon task block on a simple valence and arousal 9-point likert scale.

Psychological distress The experiment ends with the participant answering the 4 psychological health questionnaires: PHQ-9, GAD-7, PSS, STAI-T. They help us asses the predisposed mood.

We conducted a repeated measure analysis of variance (ANOVA) to analyse the two dependent variables, reaction time (RT) and accuracy separately across distress groups, No Distress (ND) and Distress (D). The division of distress groups was assisted by pearson's correlation (Sedgwick, 2012) analysis.

The self-reported generalized anxiety (GAD-7) and depression (PHQ-9) scores met the assumption of bivariate normality as tested by Shapiro-Wilk ($p = 0.108$). The preliminary analysis in this paper uses only PHQ-9 and GAD-7.

Mauchly's test of sphericity was used to test for sphericity when number of levels in a factor are more than 2. We applied Greenhouse-Geisser correction when the sphericity correction was violated. Sphericity had to be checked only for background music, which had 4 levels. The results section does not mention factors and interactions which did not show a significant effect (p = <0.05). Further, post-hoc analyses were performed for the factors with significant effect and then bonferroni correction was applied to the p value.

Table 1: Post Hoc Comparisons - Background music BMIS

		Mean Difference	Cohen's d	p_{bonf}
HVHA	HVLA	−0.168	−0.024	1.000
	LVHA	2.548	0.370	$< .001^{***}$
	LVLA	1.801	0.261	0.028^{*}
HVLA	LVHA	2.717	0.394	$< .001^{***}$
	LVLA	1.969	0.286	0.012^{*}
LVHA	LVLA	−0.747	−0.108	1.000

Note: Results are averaged over levels of: distress Groups.
Note: P-value are adjusted to compare a family of 6
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Results

Analysis flow For each participant, we obtained the mean reaction time (RT) and accuracy (acc) for the local and global task in every Navon task block condition. For a participant, we took the mean RT for the correct trials. Accuracy was given by ratio of correctly answered trials to the total number of trials. All the analysis was performed using JASP software (JASP Team, 2024).

Table 2: GAD-7 and PHQ-9 scores

	Mild or below score < 10	Moderate or higher score >= 10
GAD-7	67	26
PHQ-9	60	33

Distress groups Since anxiety (GAD-7) and Depression (PHQ-9) showed a strong correlation (*pearson's* $r = 0.77$, $p < 0.001$), the distress groups were divided by a combination of both GAD-7 and PHQ-9 scores. Table 2 illustrates the categorization of participants based on the individual scales. Participants reporting moderate or higher score either on anxiety (GAD-7 score >= 10) (Kroenke et al., 2007) or depression (PHQ-9 score >= 10) (Kroenke & Spitzer, 2002) were classified into the "Distress" (D) group. The ones scoring below 10 in both GAD-7 and PHQ-9 were categorized into the "No distress" (ND) group. We had a total of 54 participants in the ND group and 39 in the D group where 20 participants scored >= 10 on both GAD-7 and PHQ-9.

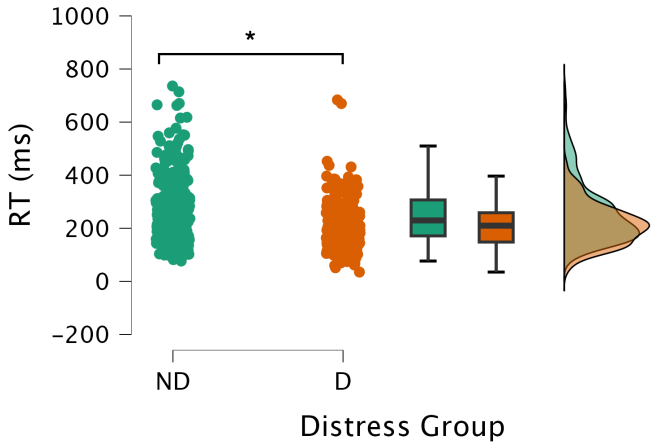


Figure 3: Raincloud plot for mean Reaction Time (RT) in No Distress (ND) and Distress (D) groups.
Note: Results are averaged over levels of: BgM and PL.
* denotes $p < 0.05$

Background Music on BMIS A two factorial, i.e., 4 (background music(BgM): HVHA, HVLA, LVHA, LVLA) as within group X 2 (Psychological distress: No distress (ND) and distress (D)) as between group, mixed repeated measure ANOVA was performed analyse the pleasant-unpleasant BMIS score. The BMIS score tells us the effect of background music on immediate mood. The results demonstrated a statistically significant influence of BgM on BMIS ($F(3, 276) = 8.992$, $p < 0.001$, $\eta^2 = 0.025$).

Furthermore, a statistically significant low BMIS score was observed by the distress groups than the non-distress group ($F(1, 91) = 10.61$, $p = 0.002$, $\eta^2 = 0.075$).

The post hoc analysis presented in Table 1 indicates a more pleasant experience (higher BMIS score) for BgM with high valence compared to those with low valence.

Perceptual Level Processing A three factorial, i.e., 4 (background music (BgM): HVHA, HVLA, LVHA, LVLA) X 2 (Perceptual level (PL): Global and local) as within group X 2 (Psychological distress: No distress (ND) and distress (D)) as between group condition, mixed repeated measure ANOVA was performed to asses the impact of BgM and PL on reaction time and accuracy. A statistically significant dif-

ference in RT was observed between the PLs ($F(1, 92)$ = 63.19, p = < .001, η^2 = 0.003), and distress groups ($F(1, 91)$ = 4.997, p = 0.028), η^2 = 0.0.4). We also observed the interaction between PL * distress group ($F(92, 92)$ = 4.591, p = 0.035, η^2 = 0.001). For the background music factor, Mauchly's test indicated a violation of the sphericity assumption (*Mauchly's W* = 0.875, p = 0.035) and Greenhouse-Geisser (ε = 0.922) correction was applied. Notably, there was no statistically significant of background music on RT of perceptual level judgement task ($F(2.765, 251.59)$ = 2.227, p = 0.091).

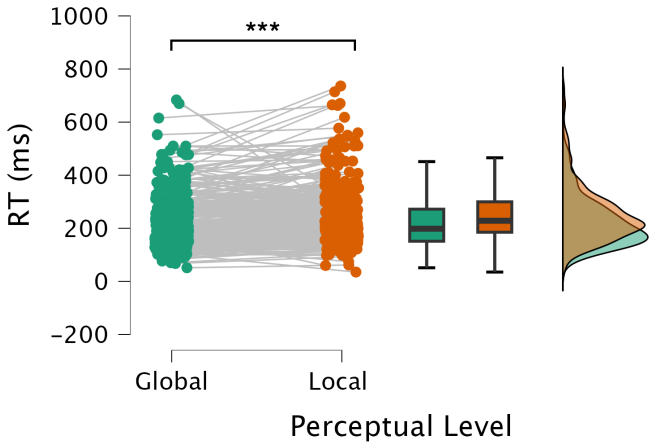


Figure 4: Raincloud plot for mean Reaction Time (RT) in Global and Local perceptual level.
Note : Results are averaged over levels of: BgM and Distress groups. *** denotes $p < 0.001$

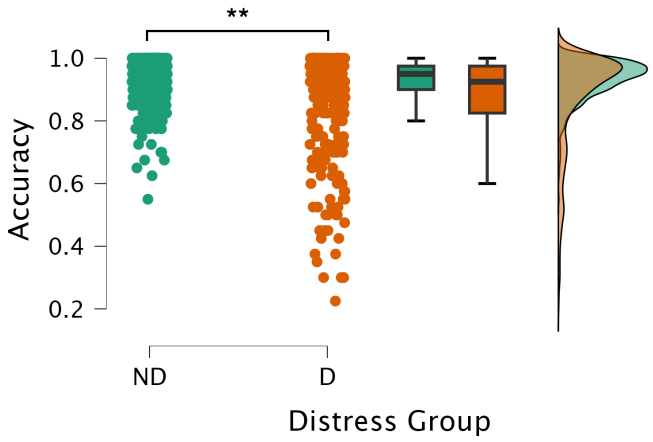


Figure 5: Raincloud plot for Accuracy in No Distress (ND) and Distress (D) groups.
Note : Results are averaged over levels of: BgM and PL.
** denotes $p < 0.01$

Further, we observed a statistically significant difference in accuracy among the distress groups ($F(1, 91)$ = 7.899, p = 0.006, η^2 = 0.062).

We separately performed post hoc analysis on RT and accuracy for the distress groups. RT for the perceptual level judgement task averaged over perceptual levels was slower in ND group (*Mean difference* = 42.78ms, *Cohen's d* = 0.41, p_{bonf} = 0.028) (Figure 3), however, the ND group exhibited a six percentage higher accuracy compared to the D group (*Cohen's d* = 0.52, p_{bonf} = 0.006) (Figure 5). Since there was a significant effect on the interaction of PL and distress group on RT, we performed a post hoc analysis revealing a faster global RT than local RT in both the distress groups, as outlined Table 3. Additionally, we observed that ND group has a significantly slower local processing as compared to global processing of D group as seen in Table 3.

Global Precedence Effect A two factorial, i.e., 4 (background music(BgM): HVHA, HVLA, LVHA, LVLA) X withing group 2 (Psychological distress), mixed repeated measure ANOVA was performed analyse the effect on global precedence effect (global RT - local RT) (Navon, 1977). The results indicated no statistically significant effect of BgM or interaction of BgM and distress groups. A statistically significant main effect of distress groups is seen in the magnitude of the global precedence effect ($F(1, 91)$ = 4.59, p = 0.035, η^2 = 0.013). A post hoc analysis shows a statistically significant result that ND group has a higher global precedence effect (more negative value) as compared to D group (*Mean difference* = -16.09ms, *Cohen's d* = -0.23, p_{bonf} = 0.035) (Figure 6).

The post hoc analysis showed a statistically significant faster global RT as compared to local RT (*Mean Difference* = -29.84ms, *Cohen's d* = -0.288, p_{bonf} =< 0.001) when averaging over BgM and distress groups (Figure 4).

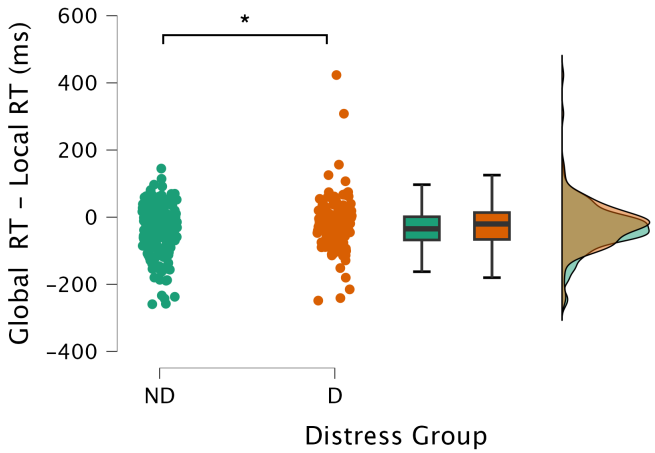


Figure 6: Raincloud plot for Global precedence effect in No distress (ND) and Distress (D) group.
Note: Results are averaged over levels of: BgM.
* denotes $p < 0.05$

Discussion and Conclusion

The current study examined the effect of psychological distress on perceptual level task performance. Further, we were

Table 3: Post Hoc Comparisons - distressGroup * Perceptual Level

		Mean Difference	Cohen's d	p_{bonf}
ND, Global RT	D, Global RT	34.740	0.336	0.468
	ND, Local RT	−37.883	−0.366	$< .001^{***}$
	D, Local RT	12.943	0.125	1.000
D, Global RT	ND, Local RT	−72.623	−0.701	0.002^{**}
	D, Local RT	−21.797	−0.211	0.002^{**}
ND, Local RT	D, Local RT	50.826	0.491	0.064

Note: Results are averaged over levels of: distress Groups.
Note: P-value are adjusted to compare a family of 6
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

interested in investigating the relationship between transient mood induction by using background music, psychological distress, and perceptual level processing. We observed a main effect of background music on mood. Further, we observed an overarching effect of predisposed mood, encompassing depression and anxiety, on individuals' transient mood experience and perceptual task performance. Below, we delve into these results in ascending order, covering the effect of music on mood, perceptual level processing, and the interaction between psychological distress, mood, and perpetual level task performance, emphasizing the global precedence effect.

We observed a significant main effect of background music on immediate mood experience, irrespective of participants' distress level. Exposure to high-valence background music elicited a more pleasant mood experience compared to low-valence background music. Though the transient-induced mood corresponded to the background music mood, the mood experience differed for the distress and non-distress groups. The result aligns with our hypothesis, suggesting that high valence background music leads to a more pleasant mood experience than low valence background music. Further, we observed an overall lower BMIS score for the distress group than the non-distress group. The smaller difference between pleasant and unpleasant experience by the BgM music among the D than ND group indicates reduced emotional reactivity regardless of nature of the stimuli than appropriately varying level of reaction to the emotional stimuli. We need further data analysis to disentangle the emotional reactivity and the switching cost because of the cognitive overload.

Further, we observed a faster reaction time (RT) for the perceptual level task performance by the distress group than the non-distress group. However, we observed a contradictory result for the two groups when we analysed accuracy, indicating a speed-accuracy tradeoff (Figure 3 and Figure 5).

In addition, we observed a significantly smaller global precedence effect in the distress group than in the non-distress group. The global precedence effect emphasizes the competitive nature of perceptual processing, in which global processing typically takes precedence over local processing (Navon, 1977) (Figure 6). Therefore, we see global stimuli faster than local stimuli (Figure 4). However, studies have indicated that factors like mental illnesses can diminish the global precedence effect (Ji, Yap, Best, & McGeorge, 2019).

The notable difference in the global precedence effect between the distress and no-distress groups supports the theory of positive emotion. A positive mental state broadens the attentional scope and facilitates global rather than local feature processing. Given that the psychological distress state aligns with a narrower focus of attention, it naturally leans towards local feature processing rather than global. The smaller global precedence effect by the distress group is consistent with our second hypothesis, proposing that individuals undergoing psychological distress may allocate their attention to more local and detailed information, enhancing the processing of local features over the global ones.

In conclusion, the current results show that the overarching impact of predisposed mood, encompassing depression and anxiety, significantly influences both transient mood experiences and perceptual task performance. The study found a compelling speed-accuracy tradeoff, with the distress group demonstrating faster reaction times but compromised processing relative to their psychologically healthy counterparts. Additionally, the significantly smaller global precedence effect observed in the distress group supports the theory of positive emotion, highlighting how a positive mental state facilitates global rather than local feature processing. In contrast, individuals undergoing psychological distress tended to allocate their attention more towards local and detailed information, resulting in a diminished global precedence effect. The study contributes valuable insights into the complex interaction between the current mood state, psychological distress or psychological predisposition, and perceptual processing.

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