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Does mood help or hinder executive functions? Reactivity may be the key

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ABSTRACT

Our ability to utilize executive functioning (EF) in day-to-day life is influenced by our mood, which consists of two fundamental dimensions reflecting positive and negative affect. It remains unclear, however, what impact these affective experiences have on our executive skills and whether this association may be influenced by individual differences in emotional reactivity. Our study investigated the interplay of emotional reactivity, naturally occurring variations in affective dimensions underlying mood, and latent constructs of response inhibition and working memory in an undergraduate sample. Reactivity moderated an association between negative affect and EF, such that high-reactive individuals performed better on EF tasks when experiencing high levels of negative affect whereas low-reactive individuals showed the converse pattern. These results are discussed through the lens of mood-related effects on information processing styles and the availability of cognitive resources to cope with current situational demands. An implication of this work is that emotional reactivity is an important factor in understanding how affective experiences influence executive skills and, by extension, everyday function.

1. Introduction

Think before you act. This simple instruction is the basis for keeping oneself from getting into trouble at work and at school, in social situations and with the law. Keeping track of important information (i.e., working memory; Baddeley, 1992) and withholding responses that are pre-potent yet inappropriate (i.e., response inhibition; Nigg, 2000) are foundational executive skills that play an integral role in our ability to navigate the ever-changing milieu of day-to-day life (Friedman & Miyake, 2017). These skills, commonly referred to as executive functions (EF), have a protracted course of development and are not fully mature until the second decade of life (for review see Luna, Marek, Larsen, Tervo-Clemmens, & Chahal, 2015). Even in adulthood, however, there exists a great deal of variability in how successful individuals are at using their executive skills – particularly in situations that are affective in nature (Pessoa & McMenamin, 2017).

In one of the most basic yet well-validated of taxonomies, mood is represented by two distinguishable feeling states that broadly reflect enthusiasm (i.e. positive affect) and distress (i.e. negative affect) along a continuum of low to high emotional arousal (Watson, Clark, & Tellegen, 1988; Watson & Tellegen, 1985). In this framework, positive and negative affect are orthogonal dimensions such that an individual may simultaneously experience high, low, or mixed levels of both. Compared with emotions, moods tend to be less intense, longer lasting, and typically lack a well-defined object of reference (Larsen, 2000). Because moods may thus be less amenable to regulatory efforts and more prone to dysfunction, they have the potential to exert particularly salient and widespread influences on EF.

In their review of the extant literature on this topic, Mitchell and Phillips (2007) identified three theoretical accounts for the impact of mood states on select executive skills. Cognitive load theory posits that moods place demands on cognitive resources that interfere with the application of EF, leading any mood state to interfere with EF-task performance. In contrast, mood-as-information theory suggests that the impact of mood on EF-task performance varies as a function of mood state. According to this perspective, positive moods signify the absence of threat and promote a heuristic processing style that hinders EF-task performance, whereas negative moods signify the presence of threat and promote an analytic processing style that has the converse effect. A final theory proposes that positive moods activate a network of positive cognitions that facilitate problem-solving on interesting and/or novel EF tasks. Based on the balance of available evidence, Mitchell and Phillips (2007) concluded that positive moods likely bolster cognitive flexibility/creativity, hinder working memory, and have inconsistent effects on response inhibition. They further noted, however, that little research had explored the interplay of negative mood and EF, nor had studies explored potential moderators of mood-EF associations – an important consideration given the heterogeneity of research findings.

Building on this body of work, our study explored whether mood states are differentially associated with the core executive skills of

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working memory and response inhibition, and the extent that these associations are moderated by the onset, intensity, and duration of one's affective experience (i.e., emotional reactivity). We evaluated emotional reactivity as a potential moderator of mood-EF associations because individual differences in this construct are evident early in life, persist into the adult years, and are linked to factors that increase risk for psychopathology (Davidson, 1998; Larsen & Diener, 1987; Sturm, Haase, & Levenson, 2016). In a departure from many studies in this field, we opted to assess naturally occurring variations in mood because it is believed to be more representative of the kinds of mood fluctuations that characterize our daily, lived experience (Parrott & Hertel, 1999). Rather than focus solely on positive affect or negative affect in our analyses, however, we examined both in tandem because doing so is likely to provide a more accurate assessment of an individual's mood compared with either dimension examined in isolation (Watson et al., 1988; Watson, Wiese, Vaidya, & Tellegen, 1999).

Our predictions were derived from the integration of two theories described by Mitchell and Phillips (2007). Consistent with mood-as-information theory, we expected negative affect to promote an analytic thinking style that would bolster performance on our EF tasks, and positive affect to promote a heuristic thinking style that would have the opposite effect. We further anticipated, however, that the influence of mood-induced processing styles on EF would vary under conditions of cognitive load, with load being inversely related to emotional reactivity. Consequently, we hypothesized that better levels of EF task performance would be observed in highly reactive individuals experiencing high levels of negative affect compared with individuals experiencing other combinations of reactivity and affect. These predictions are presented in Table 1.

Table 1
The anticipated interplay of affective dimensions underlying mood with reactivity on executive functioning performance based on cognitive load theory (rows) and mood-as-information theory (columns), with asterisks denoting the strength of the prediction.

	High Negative Affect (more analytic)	High Positive Affect (more heuristic)
High Emotional Reactivity (lower cognitive demands)	Better**	Worse*
Low Emotional Reactivity (higher cognitive demands)	Worse*	Worse**

2. Method

2.1. Participants and procedure

Participants were recruited through a departmental pool of students enrolled in psychology courses at the University of [blinded]. Ninety-six undergraduates completed a 90-minute session for course credit (mean age = 19.8 years, age range = 17 to 30, 66% female, 31% Asian, 30% Caucasian, 16% South Asian, 23% Other). Because this was an individual differences design, measures were presented in the following fixed order across all participants: Letter-Number Sequencing, Flanker, Positive and Negative Affect Schedule, Automated Reading Span, Emotion Regulation Questionnaire, Stop Signal, Emotion Reactivity Scale, Automated Operation Span, Brief Symptom Inventory, Spatial Compatibility, and a Demographic Questionnaire. The Emotion Regulation Questionnaire and Brief Symptom Inventory are the focus of another study and are not described here further.

2.2. Measures

2.2.1. Working memory tasks

2.2.1.1. Letter-Number Sequencing (Wechsler, Coalson, & Raiford, 2008). Participants were required to re-sequence an auditory string of jumbled numbers and letters in alpha-numeric order. Strings increased in length from two to nine items, with each length presented in a block of three trials, until participants failed to correctly repeat all three strings within a block. A total score was derived by summing the number of correctly recalled strings (mean = 20.87, standard deviation = 2.27, skew = 0.02, kurtosis = −0.67). Internal consistency could not be ascertained in our sample as only total scores were available for analysis; however, test-retest reliability of this task is 0.88 per the WAIS-IV manual.

2.2.1.2. Automated Reading Span and Operation Span (Unsworth, Heitz, Schrock, & Engle, 2005). Participants were instructed to hold letters in mind whist evaluating either reading problems or math problems that were interleaved between each letter. Both tasks presented strings ranging from three to seven letters in length in three blocks consisting of five strings each. An absolute score was derived by summing the number of trials on which the participant recalled all letters correctly (reading span: mean = 35.37, standard deviation = 17.18, skew = 0.46, kurtosis = −0.40; operation span: mean = 43.39, standard deviation = 19.89, skew = −0.88, kurtosis = 1.98). Internal consistency was 0.89 for operation span and 0.78 for reading span using participants' scores from the three blocks of each task.

2.2.2. Inhibition tasks

2.2.2.1. Spatial Compatibility (Simon & Rudell, 1967). Participants were required to rapidly respond to the direction of a peripherally presented left- or right-pointing arrow using either a left or right keypress. Following a central fixation of 500 milliseconds (ms), an arrow appeared on either the right or left side of the screen. On compatible trials, the arrow pointed in the same direction as the side on which it appeared (e.g., right pointing arrow on the right side), whereas the converse occurred on incompatible trials (e.g., right pointing arrow on the left side). Following a keypress, or up to 2000 ms, a blank interval of 1000 ms was presented. The task included 24 trials in each condition, with trial type randomly inter-mixed. Inhibitory ability was assessed by correct RT (ms) on incompatible trials (mean = 517.06, standard deviation = 91.85, skew = 0.39, kurtosis = 0.82). Internal consistency of trials in the incompatible condition was 0.80.

2.2.2.2. Flanker (Eriksen & Eriksen, 1974). Parameters of the task were identical to those of the spatial compatibility task, except that the stimulus consisted of a central arrow flanked on either side by two arrows that pointed in the same direction on compatible trials (e.g., right-pointing central arrow surrounded by right-pointing flankers) and in the opposite direction on incompatible trials (e.g., right-pointing central arrow surrounded by left-pointing flankers). Inhibitory ability was assessed by correct RT (ms) on incompatible trials (mean = 456.61 standard deviation = 65.82, skew = 1.71, kurtosis = 1.47). Internal consistency of trials in the incompatible condition was 0.89.

2.2.2.3. Stop Signal (Logan, Cowan, & Davis, 1984). Task parameters were similar to those of the spatial compatibility task, except that participants were instructed to respond to a centrally presented pink or green star and to stop their response when the star was followed by a tone. Timing of the tone was determined using a dynamic tracking algorithm such that participants were able to stop their response on approximately 50% of trials. The task was presented in four blocks, with each block including 8 (25%) stop trials and 24 (75%) go trials. Inhibition was indexed using the stop signal reaction time (SSRT), calculated as the mean delay of the stop signal subtracted from the average time taken to correctly respond to the stimulus on go trials in ms (mean = 304.85, standard deviation = 52.36, skew = 1.00, kurtosis, 1.47). Internal consistency of stop trials was 0.96.

2.2.3. Self-report questionnaires

2.2.3.1. Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). This 20-item scale was conceived of as a mood measure by its developers. In the version used in our study, participants were asked participants to rate their experience of 10 positive adjectives (e.g., "excited") and 10 negative adjectives (e.g. "afraid") on a 5-point Likert scale ranging from *very slightly or not at all* (1) to *extremely* (5) over the past week. Responses were totaled within each subscale, which were internally consistent in our sample (positive affect: mean = 30.65, standard deviation = 7.11, α = 0.86, skew = −0.13, kurtosis = −0.27; negative affect: mean = 22.60, standard deviation = 8.24, α = 0.90, skew = 0.60, kurtosis = −0.41).

2.2.3.2. Emotion Reactivity Scale (ERS; Nock, Wedig, Holmberg, & Hooley, 2008). This 21-item scale asked participants to rate their reactions to affective events using a 5-point Likert scale ranging from *not at all like me* (0) to *completely like me* (4). Included were 8 items of emotional sensitivity (e.g., "my feelings get hurt easily"), 3 items of emotional persistence (e.g., "when something happens that upsets me, it's all I can think about for a long time"), and 10 items of emotional arousal/intensity (e.g., "when I experience emotions I feel them very strongly/intensely"). Responses were summed to create a total score within each subscale, which were internally consistent in our sample (sensitivity: mean = 12.65, standard deviation = 7.64, α = 0.87, skew = 0.83, kurtosis = 0.37; arousal/intensity: mean = 10.42, standard deviation = 5.81, α = 0.85, skew = 0.55, kurtosis = −0.15; persistence: mean = 6.45, standard deviation = 3.69, α = 0.77, skew = 0.45, kurtosis = −0.63).

2.2.3.3. Demographic Questionnaire. Included were questions regarding age, sex, ethnicity, and medical history.

Table 2
Correlations between affective dimensions of mood, emotional reactivity, and executive functioning.

Construct	1	2	3	4	5
1. Positive Affect	–				
2. Negative Affect	−0.16	–			
3. Emotional Reactivity	−0.03	0.55*	–		
4. Inhibition	−0.03	0.11	0.06	–	
5. Working Memory	0.07	−.07	0.03	−0.44*	–

* $p < .001$. There were no significant associations at $p < .05$ or trends at a more liberal threshold of $p < .10$.

3. Results

Initial inspection of data led to the removal of one participant due to biased responding on the questionnaires (i.e., same response for all items). Data were missing from seven participants on select tasks due to technical problems and were excluded for three participants on the automated span tasks due to high error rates. Missing and/or excluded data were replaced using an expectation-maximization algorithm in SPSS. The ensuing dataset of 95 participants was then inspected for outliers and normality. Following the suggestion of Osborne and Overbay (2004), six univariate outliers on RT tasks were reduced to a value that was three standard deviations above the group mean (< 1% of all data). Truncating these values ensured that the extremely slow mean reaction times of these participants did not unduly influence the overall group mean for these RT tasks, without completely removing their data. No bivariate or multivariate outliers were identified. As noted above, all measures were approximately normally distributed.

First, a measurement model with latent factors of inhibition (Flanker, Spatial Compatibility, Stop Signal), working memory (Reading Span, Operation Span, Letter-Number Sequencing), and emotional reactivity (sensitivity, arousal/intensity, persistence) was tested using AMOS and was determined to have a good fit [$\chi^2(24) = 28.05$, $p = .26$, $CFI = 0.98$, $RMSEA = 0.04$ (90% $CI = 0.00$–0.09)]. Bivariate correlations amongst these latent constructs and measures of positive and negative affect are provided in Table 2.

Next, a structural model was developed using centred predictors to examine the interplay of emotional reactivity and affect vis-à-vis EF. This model yielded a poor fit [$\chi^2(49) = 82.92$, $p = .002$, $CFI = 0.90$, $RMSEA = 0.09$ (90% $CI = 0.05$–0.12), $AIC = 192.92$]. In subsequent iterations of the model, non-significant interactions involving emotional reactivity and positive affect on inhibition and working memory were removed, followed by non-significant main effects of positive affect on these same constructs. Fit indices remained poor, and AIC values comparatively large, until the final refined model was assessed [$\chi^2(37) = 44.68$, $p = .18$, $CFI = 0.98$, $RMSEA = 0.05$ (90% $CI = 0.00$–0.09), $AIC = 124.68$]. In this last model, shown in standardized form in Fig. 1, emotional reactivity moderated the impact of negative affect on both inhibition ($C.R. = -2.29$, $p = .02$) and working

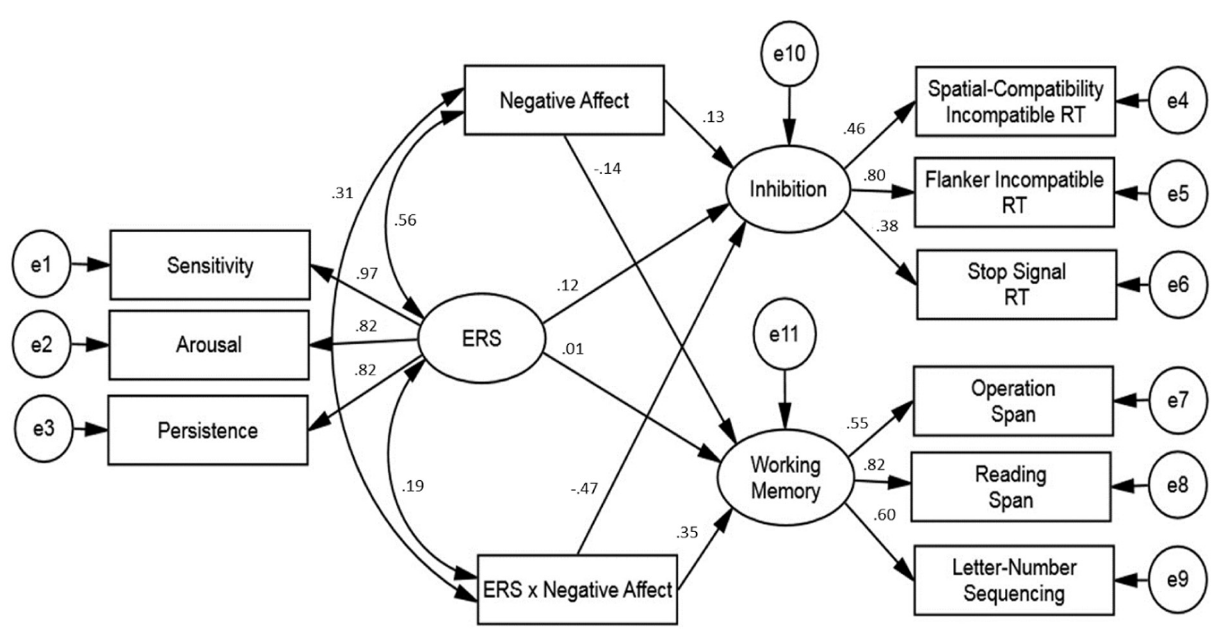

Fig. 1. Final structural model demonstrating the influence of emotional reactivity and negative affect on EF task performance (standardized solution, N = 95).

Table 3
Unstandardized coefficients and significance levels for model in Fig. 1 (standard errors in parentheses, N = 95).

Parameter estimate	*B*	*p*
Measurement model		
Emotional Reactivity → Sensitivity	1.00	
Emotional Reactivity → Arousal	0.64 (0.06)	< .001
Emotional Reactivity → Persistence	0.41 (0.04)	< .001
Inhibition → Stop Signal RT	1.00	
Inhibition → Flanker Incompatible RT	2.65 (1.07)	.01
Inhibition → Spatial Compatibility Incompatible RT	2.12 (0.83)	.01
Working Memory → Operation Span	1.00	
Working Memory → Reading Span	1.28 (0.33)	< .001
Working Memory → Letter-Number Sequencing	0.12 (0.03)	< .001
Structural model		
Emotional Reactivity → Inhibition	0.32 (0.42)	.45
Emotional Reactivity → Working Memory	0.01 (0.22)	.95
Negative Affect → Inhibition	0.31 (0.36)	.39
Negative Affect → Working Memory	−0.19 (0.19)	.31
ERxNA → Inhibition	−0.16 (0.07)	.02
ERxNA → Working Memory	0.06 (0.03)	.01
Covariance of Emotional Reactivity and Negative Affect	95.03 (51.73)	.07
Covariance of ERxNA and Emotional Reactivity	137.65 (48.90)	.01
Covariance of ERxNA and Negative Affect	33.91 (7.30)	< .001

memory ($C.R. = 2.54$, $p = .01$).[1] Table 3 presents the unstandardized parameter estimates and associated significance levels of this model.

Using latent factor scores derived from AMOS, interactions were further explored in SPSS using PROCESS (Hayes, 2014).[2] Simple slopes for the regression of negative affect on EF were tested at low (−1 SD below the mean), average, and high (+1 SD above the mean) levels of reactivity. As shown in Fig. 2, there was no significant or trend-level effect of negative affect on inhibitory performance at average levels of emotional reactivity, $b = 0.25$, $SE = 0.23$, $p = .28$. However, high levels of negative affect significantly predicted worse inhibitory performance for low-reactive individuals, $b = 1.03$, $SE = 0.31$, $p = .001$, and there was a non-significant trend for high levels of negative affect to predict better inhibitory performance for high-reactive individuals, $b = -0.53$, $SE = 0.30$, $p = .08$.

As shown in Fig. 3, a similar pattern was observed for working memory, such that working memory performance was significantly better for low-reactive individuals experiencing low levels of negative affect, $b = -0.55$, $SE = 0.19$, $p = .005$; however, no significant or trend-level effect was evident at average levels of emotional reactivity, $b = -0.16$, $SE = 0.14$, $p = .27$, or in high-reactive individuals, $b = 0.23$, $SE = 0.19$, $p = .22$.

4. Discussion

This study explored whether associations between naturally occurring variations in mood and EF were moderated by individual differences in emotional reactivity. Using a latent variables approach to model the core executive skills of working memory and response inhibition, we found that negative (but not positive) affect was associated with EF-task performance; however, the nature of this relationship varied depending on the moderator. Specifically, high negative affect predicted worse EF-task performance for individuals who were low in reactivity but better EF-task performance for individuals who were high in reactivity. This finding is consistent with our predictions, informed by the integration of mood-as-information theory and cognitive load theory, in which we expected that negative affect would promote an analytic processing style that bolstered EF performance depending on the extent that individuals' cognitive resources were engaged by their mood state.

Although we did not directly examine whether positive and negative affect engendered differences in information processing, prior research has demonstrated that negative mood promotes an analytic thinking style which may be advantageous for some kinds of EF-tasks (e.g., Forgas, 2017; Gasper & Clore, 2002). The results of our study indicate that this effect may be overshadowed by the cognitive demands that are presumed to follow from high levels of negative affect. Importantly, we suggest that emotional reactivity is key to understanding the extent of these cognitive demands, as it speaks to the issue of what is 'typical' with regards to mood state at the level of the individual. There is some evidence that highly reactive individuals experience moods that are stronger, longer, and more frequent than their less reactive counterparts, with our own data pointing to an effect of reactivity on negatively valenced moods in particular (see also Nock et al., 2008; Thake & Zelenski, 2013). Though speculative, negative moods may be less cognitively depleting for individuals who are highly reactive because they are more 'practiced' at functioning in negative mood states. In other words, using EF whilst in a negative mood may be akin to learning a skill that is paralleled by concomitant changes in the distribution and/or intensity of underlying neural activation, resulting in less engagement of prefrontal cortex and more recruitment of posterior brain regions as the skill becomes practiced (Johnson, 2001). This idea, which could be further explored in the context of functional neuroimaging, would have clear implications for the influences of mood on EF, given that prefrontal cortex is a hub in the neural circuity supporting executive skills and is a candidate region for the integration of mood and cognition (Aoki et al., 2011; Gray, Braver, & Raichle, 2002; Luo et al., 2014).

Informed by the work of Watson and colleagues, our assessment of mood focused on positive and negative affect as experienced over the past week. These affective dimensions have been distinguishable in factor-analytic studies of mood and considerable work has demonstrated that an individual's current mood is more accurately captured by determining his or her placement along both of these dimensions compared with either in isolation (Watson et al., 1988; Watson & Tellegen, 1985). It is important to note, however, that other conceptualizations of mood posit alternate, additional, and/or finer-grained dimensions that may be informative to explore (e.g., Larsen & Diener, 1992; Russell, 2003; Watson et al., 1999; Yik, Russell, & Steiger, 2011). For example, one recent study of young adults demonstrated that induction of anxiety, but not anger, impaired performance on a card sorting task compared to a neutral baseline (Shields, Moons, Tewell, & Yonelinas, 2016). Although anxiety and anger are high arousal negative feeling states, they engage different motivational systems – namely approach and avoidance – with in this case seemed to exert differential effects on behaviour (see also Carver, 2004, 2006; Gable, Poole, & Harmon-Jones, 2015; Higgins, 1997; Katzir, Eyal, Meiran, & Kessler, 2010; Wang, Liu, & Jiang, 2013). We further suggest that expanding the repertoire of executive skills to include others in the executive collective as well as measures of EF that reflect its application in less structured, real-world contexts are likely to be fruitful lines of future inquiry (Jurado & Rosselli, 2007; Toplak, West, & Stanovich, 2013).

Contrary to our predictions, we found no association between positive affect and EF-task performance: there was no hint of a main effect or interaction in our full a priori model or in a post hoc model in which the influence of negative affect was removed. Psychometric issues are an unlikely explanation of this null finding, given that positive affect was measured reliably in our sample and demonstrated variance in

[1] Results were similar when the contribution of processing speed to executive task performance was controlled using correct average RT on go trials of the Stop Signal task and also when impute, post hoc analyses in which the anxiety subscale of the Brief Symptom Inventory and Emotional Reactivity Scale were examined in relation to EF performance were not significant, which suggests that our findings are likely not attributable to state anxiety.

[2] When examined individually, five of six tasks replicated the interactions demonstrated with latent variables. The exception was Operation Span, in which participants performed worse when experiencing more negative affect but emotional reactivity did not moderate this association.

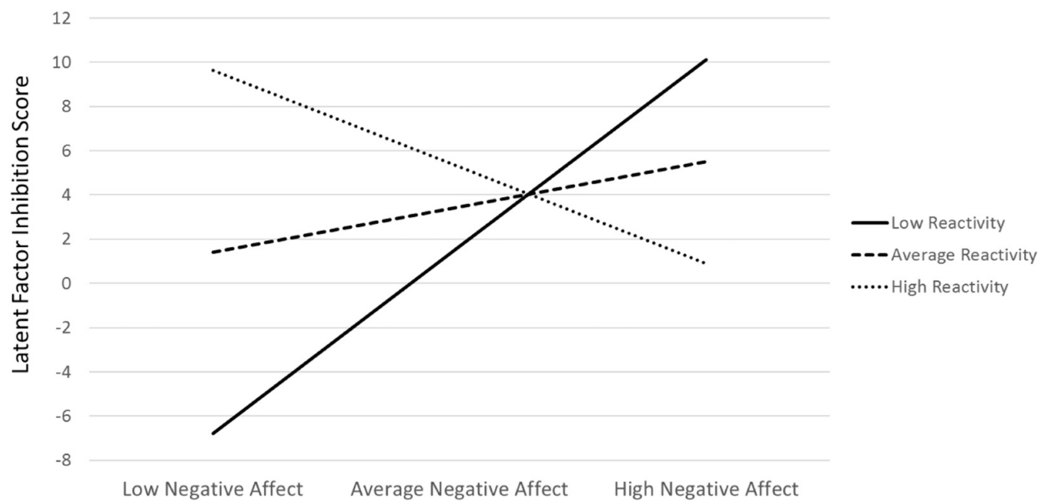

Fig. 2. Simple slopes showing the moderating influence of reactivity on the association between negative affect and response inhibition. Higher latent factor scores reflect worse performance.

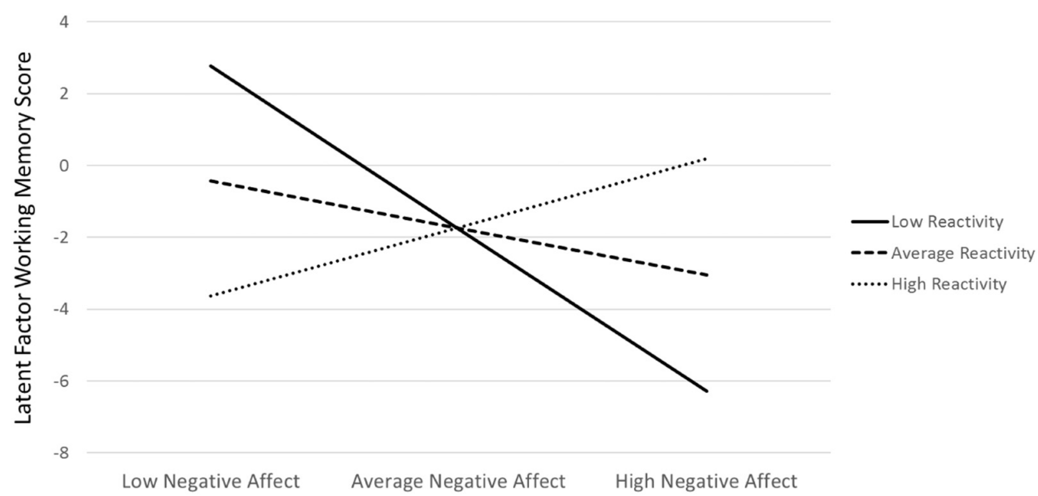

Fig. 3. Simple slopes showing the moderating influence of reactivity on the association between negative affect and working memory. Lower latent factor scores reflect worse performance.

scores with no evidence of floor or ceiling effects. We do note, however, that most extant research – including studies reviewed by Mitchell and Phillips (2007) – has entailed the use of positive mood induction procedures, typically accomplished via meditation on positive statements, exposure to mood-enhancing music or film clips, and/or recollection of pleasant autobiographical memories. In contrast, we assessed normative fluctuations in mood by asking participants to rate themselves on the extent that they had experienced positive (and negative) affective adjectives over the past week. Moving forward, it may be informative for researchers to ascertain whether these methodological differences have differential implications for the quantity and/or quality of positive (and negative) mood, or more current experiences of affect, that are endorsed by participants, and whether this in turn may account for discrepant research findings.

In conclusion, our study adds to a growing literature aimed at elucidating the interplay of mood and EF by examining how naturally occurring variations in positive and negative affect impact core executive skills as a function of individual differences in emotional reactivity. An important point suggested by our work is that a more nuanced understanding of mood-EF associations may be obtained via the integration of multiple theoretical perspectives – in this case, mood as information theory and cognitive load theory. Our results are consistent with the view that mood induced processing styles may interact with subjectively experienced cognitive demands to differentially predict the success with which one utilizes their executive skills; however, our work should be considered preliminary and future research will be required to further evaluate and expand upon the ideas we have presented. In doing so, we believe that this line of research is well poised to broaden our understanding of how individual differences in mood shape the effective application of executive skills, thereby shedding insight into an important yet relatively understudied area of human function.

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References

Aoki, R., Sato, H., Katura, T., Utsugi, K., Koizumi, H., Matsuda, R., & Maki, A. (2011). Relationship of negative mood with prefrontal cortex activity during working memory tasks: An optical topography study. *Neuroscience Research, 70*(2), 189–196.

Baddeley, A. (1992). Working memory. *Science, 255*(5044), 556–559.

Carver, C. S. (2004). Negative affects deriving from the behavioral approach system. *Emotion, 4*(1), 3–22.

Carver, C. S. (2006). Approach, avoidance, and the self-regulation of affect and action. *Motivation and Emotion, 30*(2), 105–110.

Davidson, R. J. (1998). Affective style and affective disorders: Perspectives from affective neuroscience. *Cognition & Emotion, 12*(3), 307–330.

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics, 16*(1), 143–149.

Forgas, J. P. (2017). Mood effects on cognition: affective influences on the content and process of information processing and behavior. In M. Jeon (Ed.). *Emotions and affect in human factors and human-computer interaction* (pp. 89–122). .

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex, 86*, 186–204.

Gable, P. A., Poole, B. D., & Harmon-Jones, E. (2015). Anger perceptually and conceptually narrows cognitive scope. *Journal of Personality and Social Psychology, 109*(1), 163–174.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological Science, 13*(1), 34–40.

Gray, J. R., Braver, T. S., & Raichle, M. E. (2002). Integration of emotion and cognition in the lateral prefrontal cortex. *Proceedings of the National Academy of Sciences of the United States of America. 99. Proceedings of the National Academy of Sciences of the United States of America* (pp. 4115–4120).

Hayes, A. (2014). *Introduction to mediation, moderation, and conditional process analysis. A regression-based approach. 2013.* New York: Guilford.

Higgins, E. T. (1997). Beyond pleasure and pain. *American Psychologist, 52*(12), 1280–1300.

Johnson, M. H. (2001). Functional brain development in humans. *Nature Reviews Neuroscience, 2*(7), 475–483.

Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychology Review, 17*(3), 213–233.

Katzir, M., Eyal, T., Meiran, N., & Kessler, Y. (2010). Imagined positive emotions and inhibitory control: The differentiated effect of pride versus happiness. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36*(5), 1314–1320.

Larsen, R. J. (2000). Toward a science of mood regulation. *Psychological Inquiry, 11*(3), 129–141.

Larsen, R. J., & Diener, E. (1987). Affect intensity as an individual difference characteristic: A review. *Journal of Research in Personality, 21*(1), 1–39.

Larsen, R. J., & Diener, E. (1992). Promises and problems with the circumplex model of emotion. In M. S. Clark (Ed.). *Review of personality and social psychology, No. 13. Emotion* (pp. 25–59). Thousand Oaks, CA, US: Sage Publications, Inc.

Logan, G. D., Cowan, W. B., & Davis, K. A. (1984). On the ability to inhibit simple and choice reaction time responses: A model and a method. *Journal of Experimental Psychology: Human Perception and Performance, 10*(2), 276–291.

Luna, B., Marek, S., Larsen, B., Tervo-Clemmens, B., & Chahal, R. (2015). An integrative model of the maturation of cognitive control. *Annual Review of Neuroscience, 38*, 151–170.

Luo, Y., Qin, S., Fernandez, G., Zhang, Y., Klumpers, F., & Li, H. (2014). Emotion perception and executive control interact in the salience network during emotionally charged working memory processing. *Human Brain Mapping, 35*(11), 5606–5616.

Mitchell, R. L., & Phillips, L. H. (2007). The psychological, neurochemical and functional neuroanatomical mediators of the effects of positive and negative mood on executive functions. *Neuropsychologia, 45*(4), 617–629.

Nigg, J. T. (2000). On inhibition/disinhibition in developmental psychopathology: Views from cognitive and personality psychology and a working inhibition taxonomy. *Psychological Bulletin, 126*(2), 220–246.

Nock, M. K., Wedig, M. M., Holmberg, E. B., & Hooley, J. M. (2008). The emotion reactivity scale: Development, evaluation, and relation to self-injurious thoughts and behaviors. *Behavior Therapy, 39*(2), 107–116.

Osborne, J. W., & Overbay, A. (2004). The power of outliers (and why) researchers should always check for them. *Practical Assessment, Research & Evaluation, 9*(6), 1–12.

Parrott, W. G., & Hertel, P. (1999). Research methods in cognition and emotion. In T. Dagleish, & M. J. Power (Eds.). *Handbook of cognition and emotion* (pp. 61–81). Chicheseter, UK: John Wiley & Sons.

Pessoa, L., & McMenamin, B. (2017). Dynamic networks in the emotional brain. *The Neuroscientist, 23*(4), 383–396.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145–172.

Shields, G. S., Moons, W. G., Tewell, C. A., & Yonelinas, A. P. (2016). The effect of negative affect on cognition: Anxiety, not anger, impairs executive function. *Emotion, 16*(6), 792–797.

Simon, J. R., & Rudell, A. P. (1967). Auditory SR compatibility: the effect of an irrelevant cue on information processing. *Journal of Applied Psychology, 51*(3), 300.

Sturm, V. E., Haase, C. M., & Levenson, R. W. (2016). Emotional dysfunction in psychopathology and neuropathology: Neural and genetic pathways. *Genomics, circuits, and pathways in clinical neuropsychiatry* (pp. 345–364). .

Thake, J., & Zelenski, J. M. (2013). Neuroticism, BIS, and reactivity to discrete negative mood inductions. *Personality and Individual Differences, 54*(2), 208–213.

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, 54*(2), 131–143.

Unsworth, N., Heitz, R. P., Schrock, J. C., & Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods, 37*(3), 498–505.

Wang, Z., Liu, Y., & Jiang, C. (2013). The effect of low versus high approach-motivated positive affect on cognitive control. *Acta Psychologica Sinica, 45*(5), 546–555.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070.

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin, 98*(2), 219–235.

Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology, 76*(5), 820–838.

Wechsler, D., Coalson, D. L., & Raiford, S. E. (2008). *WAIS-IV: Wechsler adult intelligence scale.* San Antonio, TX: Pearson.

Yik, M., Russell, J. A., & Steiger, J. H. (2011). A 12-point circumplex structure of core affect. *Emotion, 11*(4), 705–731.