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The influence of positive vs. negative affect on multitasking

Brent Morgan [a,*], Sidney K. D'Mello [b]

[a] University of Memphis, Memphis, TN 38152, USA
[b] University of Notre Dame, Notre Dame, IN, USA

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ABSTRACT

Considerable research has investigated how affect influences performance on a single task; however, little is known about the role of affect in complex multitasking environments. In this paper, 178 participants multitasked in a synthetic work environment (SYNWORK) consisting of memory, visual monitoring, auditory monitoring, and math tasks. Participants multitasked for a 3-min baseline phase (MT1), following which they were randomly assigned to watch one of three affect-induction videos: positive, neutral, or negative. Participants then resumed multitasking for two additional critical phases (MT2, MT3; 3 min each). In MT2, performance of the positive and neutral conditions was statistically equivalent and higher than the negative condition. In MT3, the positive condition performed better than the negative condition, with the neutral condition not significantly different from the other two. The differences in overall multitasking scores were largely driven by errors in the Math task (the most cognitively demanding task) in MT2 and the Memory task in MT3. These findings have implications for how positive and negative affective states influence processing in a cognitively demanding multitasking environment.

1. Introduction

Cognition and affect have historically been treated as separate entities (Storbeck & Clore, 2007; Zajonc, 1980, 2000). However, researchers have come to appreciate the role that affect plays across numerous aspects of cognition, including working memory (Baddeley, 2013), cognitive flexibility (Van Wouwe, Band, & Ridderinkhof, 2011), problem solving (Isen, Daubman, & Nowicki, 1987), complex learning (D'Mello & Graesser, 2012), and judgment and decision making (Blanchette & Richards, 2010; Isen, 2000; Loewenstein & Lerner, 2003; Schwarz, 2000). The vast majority of this research has focused on single task performance. Little is known about how affect influences multitasking, defined as performing two or more tasks simultaneously (dual-taking) or alternating over time spans of a few seconds (rapid task switching).

Previous findings pertaining to affect-performance relationships in single-task experiments may not generalize to multitasking environments because performing multiple tasks simultaneously is inherently different and can be more challenging than completing a single task (Monsell, 2003; Sauer, Wastell, & Hockey, 1999). This is partly due to a ‘switch cost’ which occurs during rapid task switching (Monsell, 2003), which is the form of multitasking of interest in this study. The switch cost manifests as either additional time to complete the task, an increase in errors in task execution, or both. When multitasking, people can become overloaded as working memory and attentional resources become exhausted. Furthermore, overall performance can be adversely affected when the demands of one task interfere with those of another (Altmann & Gray, 2008). Thus, with multitasking, the whole does not always equal the sum of the parts, so the role of affect during multitasking needs to be elucidated more systematically. In line with this, the purpose of this paper is to study the influence of positive and negative affect during multitasking.

1.1. Affect and cognition

Researchers have investigated differences between positive and negative affect over a wide range of individual tasks, with the former considered to be superior in selective tasks (e.g., Fredrickson, 2003; Fredrickson & Branigan, 2005; Lyubomirsky, King, & Diener, 2005). Negative affect, in contrast, has been shown to impede performance on numerous cognitive tasks, including executive functioning and memory (Marvel & Paradiso, 2004). That being said, the liabilities of negative affect are hardly universal. Negative affect has been shown to be advantageous under particular conditions, such as performance appraisal (Sinclair, 1988), persuasion (Forgas, 2007), and complex problem-solving (Barth & Funke, 2010; Fiedler, 1988). Chepenik, Cornew, and Farah (2007) also argue that the negative influence of negative affect on cognition is not near as pervasive as the literature suggests.

Cognitive processing mediates the influence of affect on task performance (Clore et al., 2001; Gasper, 2004; Gasper & Clore, 2002). The *levels of focus hypothesis* (Gasper & Clore, 2002) states that positive affect tends to promote global processing of information,

* Corresponding author.
E-mail addresses: brent.morgan@memphis.edu (B. Morgan), sdmello@nd.edu (S.K. D'Mello).

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whereas negative affect facilitates more local processing. Similar findings have shown that affect influences the scope of attention as well (Fredrickson & Branigan, 2005; Gasper & Clore, 2002; Rowe, Hirsh, & Anderson, 2007; Schmitz, De Rosa, & Anderson, 2009; Uddenberg & Shim, 2015). For example, the broaden-and-build theory (Fredrickson & Branigan, 2005) posits that positive affect (i.e., happiness) begets a wider range of attention and thought-action repertoires than a neutral or negative affective state. Recent findings suggest that positive affect facilitates whichever focus is currently dominant (Huntsinger, Clore, & Bar-Anan, 2010). That is, people in positive affective states have either a global or a local focus, depending on which of the two is primed. However, if neither is primed, people in a positive affective state would presumably adopt the global focus by default (Gasper & Clore, 2002).

The global processing associated with positive affect can also influence performance on higher level tasks (such as set-switching) and cognitive flexibility (Braem et al., 2013; Dreisbach, 2006; Dreisbach & Goschke, 2004; Dreisbach et al., 2005). In these situations, positive affect has a deleterious impact on performance when executing a to-be-maintained goal. For example, positive affect is associated with a wider field of vision (Schmitz et al., 2009), which can result in greater distractibility (Rowe et al., 2007). These distractions, in turn, can affect low-level perceptual tasks (e.g., flanker task; Rowe et al., 2007). However, this broadening in visual attention may only occur for positively valenced stimuli (Wadlinger & Isaacowitz, 2006). Thus, although people in a positive affective state are more flexible and open to environmental changes, this comes at the cost of increased distractibility (and reduced performance) when the task constraints remain constant.

Whereas positive affect increases visual attentional focus, negative affect (especially when combined with high arousal) narrows the scope of visual attention (Derryberry & Tucker, 1994; Easterbrook, 1959). Similarly, whereas positive affect increases distractibility, negative affect improves selective attention (Finucane, 2011) and cognitive control (van Steenbergen, Band, & Hommel, 2010). This allows for a deeper focus on the task at hand (Andrews & Thomson, 2009; Braem et al., 2013). This is especially true for complex tasks, which can be decomposed into smaller, more manageable components where each component is addressed in turn (Andrews & Thomson, 2009; Barth & Funke, 2010). People in a negative affective state can solve complex problems because they can focus on the individual components without getting distracted by other components (Andrews & Thomson, 2009; Braem et al., 2013). In sum, the research on the influence of affect during single task performance suggests that people in a positive affective state tend to see the forest, whereas people in a negative affective state focus on the trees.

1.2. Affect and multitasking

Although the vast majority of the research on affect has focused on single task performance, there have also been some studies on dual-task performance, which is one form of multitasking. For example, previous studies on affect in dual-task (visual + audio tasks) situations have focused on how affect reduces the attentional blink for the visual task (i.e., a reduction in the minimum refractory period before perceiving a second visual stimulus when dual-tasking). In particular, reductions in attentional blink have been associated with both positive affect (Olivers & Nieuwenhuis, 2006) and sad mood (negative affect, low arousal; Jefferies, Smilek, Eich, & Enns, 2008). Additionally, Rokke and colleagues found no changes in attentional blink associated with a mild dysphoric mood (Rokke, Arnell, Koch, & Andrews, 2002).

It is important to point out that task switching is distinct from dual-tasking, though both are considered forms of multitasking (Posner, 1990). Rapid task switching requires switching from one task to another over short time spans, whereas divided-attention tasks require concurrent completion of individual tasks (Posner, 1990). Another important difference between rapid task switching and dual-tasking is the role of distraction. When a person engages in dual-tasking, distractions may actually be beneficial because there is some evidence to suggest they can reduce the attentional blink (Arend, Johnston, & Shapiro, 2006; Olivers & Nieuwenhuis, 2005, 2006). When task switching, however, distraction shifts attention away from the task at hand, resulting in task switch costs (Monsell, 2003).

Overall, rapid task switching, which is the focus of this paper, is more complex and cognitively challenging than performing a single task, allowing for multiple approaches and strategies for task completion. For example, a person may view the environment as holistic (one large task) or as atomistic (multiple small tasks). If positive and negative affect facilitate opposing levels of focus (global vs. local), these differences should be clearly evident under the high cognitive demands of multitasking. Thus, the pertinent question is whether a more global, heuristics-driven approach engendered by positive affect or a more local, analytical approach associated with negative affect results in superior multitasking performance?

1.3. Hypotheses and current study

There are competing hypotheses on the influence of affect based on global vs. local cognitive processing. One hypothesis is that the global processing triggered by positive affect would improve multitasking performance because it would facilitate efficient processing strategies and the use of heuristics (Lucas & Diener, 2003). Furthermore, an expansion of visual attention would improve a person's ability to monitor each individual task simultaneously. The alternate hypothesis is that additional task monitoring engendered by positive affect would be distracting (increasing task switching and therefore incurring more task switch costs), and heuristic-based processing would lead to more errors when focused attention on the environment is needed. Conversely, local processing engendered by negative affect would manifest as a more analytical and bottom-up approach. This more analytical approach would increase cognitive control, which is necessary for multitasking (Altmann & Gray, 2008), and facilitate completion of individual tasks without interruption. That is, negative affect may be superior because the person would be more likely to focus on one task at a time (Andrews & Thomson, 2009; Braem et al., 2013), thus avoiding the inherent performance costs associated with rapid task switching.

To test these hypotheses, we conducted an experiment in which participants multitasked during a baseline phase, watched a film designed to induce either a positive, neutral, or negative affective state, and then resumed multitasking for two experimental phases. We included separate experimental phases to measure both the immediate and delayed influence of affect on multitasking performance. Multitasking phases were kept short (3 min) for two reasons. First, high working memory demands (which would include multitasking) can "distract" a person from a negative affective state (Van Dillen & Koole, 2007). Thus, it was imperative to have short multitasking phases to preserve group differences in affect. Second, multitasking can be exhausting, and we felt giving participants a break was appropriate so as to mitigate fatigue effects. Performance during the critical phases was compared across the three affect-induction conditions after covarying multitasking performance on previous phases.

We included a neutral condition to ascertain whether a difference between the positive and negative conditions was due to: a benefit to one affective state (state 1 > [neutral = state 2]), a penalty to one affective state ([state 1 = neutral] > state 2), or both (state 1 > neutral > state 2). Thus, the performance of the neutral condition should aid in explaining any differences between the positive and negative conditions (unless the neutral condition was either superior or inferior to both the positive and negative conditions). Considering that attending to global features (Navon, 1977) and information (Fiske & Taylor, 1991) is the default processing strategy, the neutral condition would be expected to align more closely with the positive group.