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Attentional Flexibility During Approach and Avoidance Motivational States: The Role of Context in Shifts of Attentional Breadth

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In the present studies, we aimed to understand how approach and avoidance states affect attentional flexibility by examining attentional shifts on a trial-by-trial basis. We also examined how a novel construct in this area, task context, might interact with motivation to influence attentional flexibility. Participants completed a modified composite letter task in which the ratio of global to local targets was varied by block, making different levels of attentional focus beneficial to performance on different blocks. Study 1 demonstrated that, in the absence of a motivation manipulation, switch costs were lowest on blocks with an even ratio of global and local trials and were higher on blocks with an uneven ratio. Other participants completed the task while viewing pictures (Studies 2 and 3) and assuming arm positions (Studies 2 and 4) to induce approach, avoidance, and neutral motivational states. Avoidance motivation reduced switch costs in evenly proportioned contexts, whereas approach motivation reduced switch costs in mostly global contexts. Additionally, approach motivation imparted a similar switch cost magnitude across different contexts, whereas avoidance and neutral states led to variable switch costs depending on the context. Subsequent analyses revealed that these effects were driven largely by faster switching to local targets on mostly global blocks in the approach condition. These findings suggest that avoidance facilitates attentional shifts when switches are frequent, whereas approach facilitates responding to rare or unexpected local stimuli. The main implication of these results is that motivation has different effects on attentional shifts depending on the context.

Keywords: approach–avoidance, motivation, attention control, attentional breadth, context

When viewing a complex scene, one may choose to attend to either the broad picture as a whole or the more fine-grained details. Motivational states play an important role in biasing our attention one way or the other to facilitate goal pursuit. From an evolutionary perspective, it makes sense that certain states, such as the desire to approach appetizing food or the fear of a predator, would influence attention. Understanding how motivation affects attentional focus can explain the conditions under which attention to the small details versus the big picture may change based on one's mental state. For example, while driving to work, a person's attentional focus could differ depending on whether he or she is thinking about avoiding being late versus getting to an exciting meeting. A closely related but far less examined issue is how different motivational states might affect the *flexibility* of attentional focus. Attentional flexibility is important because the ability to shift attention between different levels of focus may be advantageous in some contexts. When people are driving, for instance, does their motivational state affect their ability to shift attention between the car ahead and the broader pattern of traffic, irrespective of their initial level of attentional focus?

The present research addresses this topic by studying how context and motivational state interact to affect the flexibility of attentional breadth, which here refers to the ability to shift one's attentional orientation between global/holistic stimulus properties and local/granular stimulus properties. To our knowledge, no studies have directly examined the effect of both context and motivation on attentional flexibility. However, the present research can be informed by related studies examining interactions between motivational and/or emotional states, attentional processes, and environmental context.

Motivational States and Emotion

Much of the relevant research on the relationships between motivation/emotion and attention hinges on subtle distinctions among the constructs, so it is important to briefly comment on them here before reviewing the substantive literature. For our purposes here, *motivation* refers to a drive for action, and it is discussed in terms of two opposing orientations: approach (the impulse to move toward) and avoidance (the impulse to move away; Harmon-Jones, Harmon-Jones, & Price, 2013). *Emotion* is notably difficult to define (e.g., Barrett, 2006; Izard, 2007; Panksepp, 2007), but here it is conceptualized as a mental and bodily state with an accompanying array of motivations, cognitions, physiological changes, expressions, and subjective experiences. Emo-

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tions are alternately studied along continuous dimensions, such as positive and negative activation (e.g., Watson, Wiese, Vaidya, & Tellegen, 1999), or as a "natural kind" in discrete categories (e.g., sadness, fear, amusement; e.g., Ekman, 1999). Emotion and motivation are tightly intertwined because emotions are nearly always accompanied by impulses for an action.

In spite of this close link, the relationship between specific emotions and motivational states is complex. On one hand, theories have suggested that approach motivation underlies positive affective states, whereas avoidance motivation underlies negative affective states (e.g., Lang & Bradley, 2010). On the other hand, recent empirical work has suggested that this link is less straightforward (see Harmon-Jones et al., 2013, for a review focusing on approach motivation). First, emotional valence and motivational direction do not always map onto each other. Although approach motivation is typically associated with positively valenced emotions, such as happiness or desire, anger is a negatively valenced emotion with an approach orientation (Carver & Harmon-Jones, 2009). Indeed, anger shows the same left frontal brain activation that has been associated with other approach states (Harmon-Jones & Sigelman, 2001). Additionally, emotional states differ not only in their motivational direction but also in their motivational intensity (e.g., Gable & Harmon-Jones, 2010b). For instance, contentment and desire both have approach orientations; however, desire has much greater motivational intensity than does contentment. Motivational intensity (rather than, or in addition to, motivational direction) can have important consequences for attentional processes. States with high motivational intensity, regardless of orientation (e.g., disgust, desire), lead to a narrowed scope of attention, compared with low motivational intensity states (e.g., sadness, amusement; Gable & Harmon-Jones, 2008, 2010a, 2011; but cf. Friedman & Förster, 2010). Thus, it is important to consider both motivational direction and motivational intensity when examining the emotional states evoked in previous studies.

The present studies attempt to examine motivational processes specifically, but with the recognition that motivation is intricately linked with emotion. Because of this link, important insights can be gained from both the motivation and emotion literature, with the caveat that there is not always a straightforward relationship between a given emotion and its concomitant motivational state.

Emotion, Attention, and Attentional Flexibility

A substantial body of research has demonstrated that emotional state affects the flexibility of attention in particular and cognition in general. It has been established that positive affect facilitates a broad, flexible mode of thinking. Positive mood states—induced using refreshments, unexpected gifts, and humorous film clips—led to more inclusivity in cognitive categorizations and the production of more unusual word associations relative to a neutral condition (Isen & Daubman, 1984; Isen, Johnson, Mertz, & Robinson, 1985). Additionally, positive affect has been shown to facilitate creative problem solving (Isen, Daubman, & Nowicki, 1987) and performance on a creative fluency task (Phillips, Bull, Adams, & Fraser, 2002). Such findings suggest that positive affect may increase the flexibility of cognitive processes, allowing individuals to think more broadly and overcome dominant cognitive associations to produce unusual or creative responses. Furthermore, this increase in inclusivity and creativity does not appear to result from a general broadening of cognitive processes, but rather from flexibility to adapt cognitive processes to the task at hand. When asked to look for similarities, individuals in positive mood states create more broad, inclusive categories; however, when asked to look for differences, they are able to flexibly shift their strategy and create more narrow categories compared to a control group (Murray, Sujan, Hirt, & Sujan, 1990). The evidence for negative mood states affecting cognitive flexibility is mixed. Isen and Daubman (1984) found a non-significant trend suggesting that negative mood states may also lead to more inclusive categorization. Other studies have found no effect of negative affect on cognitive flexibility and creativity (Isen et al., 1987, 1985). At present, the link between positive affect and cognitive flexibility is by far the most consistent.

Other studies have examined flexibility in attention, and in this more specific domain, positive affect also increases flexibility. Positive affect induced using emotional images enhanced task-switching abilities on a set-shifting task, whereas negative affect did not (Dreisbach & Goschke, 2004). This improved switching ability came at the cost of increased distractibility, which is believed to result from poorer task maintenance in working memory during positive affect (Dreisbach, 2006). Other evidence suggests that positive affect increases flexibility to attend to stimuli in non-habitual ways. Baumann and Kuhl (2005) found that, following positive prime words, individuals were better able to shift from their dominant level of attentional focus (either global or local) to their non-dominant level of attentional focus. Positive affect has also been observed to reduce Stroop interference effects (Kuhl & Kazén, 1999) and to improve performance on an antisaccade task (Van der Stigchel, Imants, & Ridderinkhof, 2011), presumably by enhancing the ability to overcome dominant response tendencies. Overall, there is strong evidence suggesting that positive affective states facilitate attentional flexibility. It is important to note, however, that the emotion induction procedures used in the reviewed studies probably did not evoke high-intensity approach motivation. Rather, they mainly rely on positive affective states with low motivational intensity. Thus, it is unknown whether states with high approach motivation would enhance attentional flexibility in a similar fashion.

Motivation, Attention, and Attentional Flexibility

The effects of motivation on cognitive flexibility have also been investigated. In a series of experiments, Friedman and Förster (2000) measured participants' performance on problem-solving and categorization tasks while they performed motor actions that mimic approach (arm flexion) and avoidance (arm extension; Cacioppo, Priester, & Berntson, 1993). They found that approach cues facilitated creative problem solving and also led to more flexible categorizations. These results are in concordance with the literature on positive affect and cognitive flexibility, which also shows an increase in creativity and flexibility. Price and Harmon-Jones (2010) compared cognitive categorization in positive affective states that were high and low in approach motivation, induced using a combination of affect-relevant facial expression and postures. Replicating past findings, positive states low in approach motivation broadened categorization, but high-approach states led to narrowed and less inclusive categorization. The fact that positive states with high motivational intensity did not have the same effect as states with low motivational intensity suggests that approach motivation may not lead to the increase in flexibility observed in most previous studies of positive affect.

Other studies have specifically investigated the effect of motivation on attentional flexibility and have inconsistent results. In one study, Friedman and Förster (2005) found that approach motivation led to greater attentional flexibility compared to avoidance motivation. Specifically, they showed that approach motivation improved performance on both the Stroop task by reducing the reaction time (RT) cost of incongruent trials, and the two-back task, relative to avoidance motivation. Motivational states were induced implicitly, using virtual enactment of approach and avoidance behaviors (Study 1) and embodiment cues (Study 2). The finding that approach improves flexibility mirrors the aforementioned literature on positive affect and attention. It is worth noting that although the Stroop and two-back tasks used in this research do involve flexibly allocating attentional resources, they are also used to measure other cognitive functions such as inhibition and working memory capacity, and thus may not have provided a pure measure of attentional flexibility.

In contrast, Koch, Holland, and van Knippenberg (2008) found that avoidance motivation enhanced cognitive flexibility. In two studies, they measured participants' performance on the Stroop task and a set-shifting task while they assumed arm positions to evoke approach and avoidance motivation. Participants in the avoidance condition performed significantly better on the Stroop task compared to approach, as indexed by reduced error rates. Perhaps even more relevant to attentional flexibility, participants in the avoidance condition also showed reduced switch costs on the set-shifting task, indicating enhanced switching relative to the approach condition. This study appears to suggest that avoidance, rather than approach, enhances cognitive control abilities, including attentional flexibility. Thus, there is little agreement in the two studies that have directly studied the relationship between motivation and attentional flexibility.

Context as a Moderating Factor

The lack of consistency in this literature underscores the notion that subtle factors, such as task context, may be important to consider. Indeed, although no studies have directly examined flexibility, there is evidence that context does influence the relationship between affect and attentional focus. It is possible that affective states may influence one's reliance on contextual information. One study showed that individuals in a low arousal positive affect condition were worse at using informative contextual cues to guide performance on an upcoming trial (Fröber & Dreisbach, 2012). This finding may suggest that positive affect reduces reliance on context. On the other hand, Huntsinger, Clore, and Bar-Anan (2010) primed participants with either a global or local context, using both an unbalanced version of Navon's (1977) composite letter task (Experiment 1), and global and local word primes (Experiment 2). On a subsequent probe task, participants in a positive mood exhibited a greater global bias than those in a negative mood, but only when they had been primed with a global context. Interestingly, participants in a positive mood that had been primed with a local focus had a greater local bias than those in a negative mood. Another study examined the effect of context primes on Flanker task performance, which is often used to gauge the breadth of attention. Following a global prime, participants in a positive mood showed greater flanker compatibility effects than those in a negative mood (Huntsinger, 2012), indicating a more global focus of attention. Following a local context prime, however, the opposite pattern of results was obtained, with positive affect leading to less of a flanker compatibility effect. Taken together, these studies suggest that the relationship between emotions and attentional focus may not be fixed; rather, it may be dependent on the context. These findings are relevant to the present studies because they suggest that some emotion-attention processes are susceptible to context effects, even if these studies did not directly examine flexibility.

The Present Research

In order to address the question of how motivation and context affect attentional flexibility, it will be useful to look beyond prolonged biases in attentional breadth (e.g., across a block of trials) to faster fluctuations in breadth (e.g., from trial-to-trial) by examining how motivation affects individuals' ability to flexibly and rapidly switch between different levels of attentional breadth. In four studies, we investigated this question by examining participants' ability to rapidly shift their attention between global and local modes of attention in different motivational states. Because we are looking specifically at switching between global and local modes of attention, we will look at how motivation affects the ability to switch attention when the context requires mainly global or local attention, versus when it requires global and local attention equally. To manipulate task context, we used a modified version of Navon's (1977) composite letter task, in which the optimal degree of local versus global attention required was manipulated by block. Specifically, some blocks of trials had a greater proportion of global or local targets, and others had an equal proportion of global and local targets. Attentional flexibility was operationalized using switch costs, which are the difference in reaction time (RT) when participants need to switch between global and local levels of focus from trial to trial, compared to when they do not. Low switch costs indicate that a participant had less difficulty in rapidly switching between identifying global and local targets, and show a high degree of flexibility. Flexibility across contexts was measured by comparing switch costs across the different context conditions (mostly global, mostly local, even).

In light of the conflicting results regarding the effects of motivation and emotion on attention generally, and on attentional flexibility in particular, we considered three classes of possible outcomes. First, it is possible that either approach or avoidance motivation could impart more attentional flexibility than the other. If this were the case, it would suggest that motivational orientation is still an important factor for determining how motivation influences cognitive processes. That is, although motivational intensity has recently been demonstrated to be an important factor in determining attentional breadth (e.g., Gable & Harmon-Jones, 2010b), such a finding would show that motivational orientation also plays an important role in shaping attentional processes. There is some evidence to support both approach and avoidance as having greater attentional flexibility. If approach motivation leads to greater flexibility, it would support much of the work on positive emotions and flexibility (e.g., Dreisbach & Goschke, 2004; Murray et al., 1990), because the emotions evoked in these studies had an approach orientation even though they were relatively low in motivational intensity. On the other hand, Koch et al. (2008) found that embodied avoidance postures actually facilitated task switching. Thus, though it is unclear which motivational direction may be more likely to enhance flexibility, either result would have important implications for the study of motivation–attention interactions.

Second, it is possible that both motivational states impart more or less attentional flexibility as a function of context. Because we are aiming to evoke motivational states of comparable intensity, this finding may support the notion that motivational intensity, rather than motivational direction, is important for modulating attentional processes. If both motivational states show less flexibility on uneven blocks (mostly local and mostly global) compared to a neutral state, it would suggest motivational intensity reduces attentional flexibility. On the other hand, if the motivational conditions lead to greater or equivalent flexibility on the uneven blocks compared to neutral conditions, it would suggest that greater motivational intensity enhances attentional flexibility. Of course, if these results are observed, it will be important to determine which aspect of the motivation conditions led to the attentional changes, and to rule out potentially confounding variables such as arousal and task engagement, which would typically be greater in the motivated conditions compared to a neutral control.

Third, and perhaps most intriguingly, it is possible that context and motivational direction interact such that approach motivation imparts more flexibility than avoidance motivation (or vice versa) in some contexts, but not others. If this were the case, it would emphasize the importance of context (e.g., Huntsinger, 2012; Huntsinger et al., 2010) in determining the effect of mental states on attentional processes. More broadly, this finding would suggest that different motivational orientations might be beneficial in different contexts. For instance, if approach motivation imparts greater flexibility than avoidance motivation on uneven blocks, it would imply that adopting an approach frame of mind might be more helpful in situations where one may need to respond to infrequent environmental changes.

A series of studies were carried out to address these competing hypotheses. In Study 1, participants completed the modified composite letter task without a motivation induction, with the goals of establishing a typical response pattern for switch costs across contexts and calibrating the task for future studies. Next, Study 2 examined the effects of motivational state on switch costs across contexts. Here, in order to increase the potency of the motivation induction, both embodied arm positions and motivationally relevant images were used to evoke the targeted motivational states. Studies 3 and 4 examined the effects of motivation induced only with images (Study 3) or with embodiment cues (Study 4), with the aim of controlling for effects that are specific to each motivation induction procedure and also to replicate the findings of Study 2.

Study 1

Before testing the effect of motivation on the flexibility of attentional breadth, it was first necessary to validate the novel adaptation of the composite letter task that has a varying global–local context in the absence of a motivation manipulation. The primary aim of Study 1 was to determine whether participants' ability to shift their attentional focus changes depending on the context of the block. Context-dependent shifting ability would be evident if participants' switch costs vary as a function of the block context. We used a variety of global-to-local target ratios to characterize the degree of unbalance required to induce a context-dependent changes in attention switching abilities, if such changes do occur. Additionally, Study 1 assessed whether participants were aware of the unbalance in global-to-local target ratios, to determine whether changes in attentional flexibility occur outside of awareness or whether they are the result of a conscious decision process.

Method

Participants. Participants were 49 undergraduate students at the University of Oregon (30 women; mean age = 19.68 years, *SD* = 1.94, range = 18–29) who earned partial course credit. Participants gave informed consent under the approval of the Committee for the Protection of Human Subjects at the University of Oregon.

Procedure. Upon arriving in the lab, participants gave informed consent and completed a brief demographic questionnaire. Participants were then instructed on the modified composite letters task and completed a block of eight practice trials. Following an opportunity to ask clarifying questions about the task, participants completed the modified composite letter task. Immediately following the task, participants completed a verbal debriefing to determine the extent of their awareness of the varying global–local context by block. Participants then completed several questionnaire measures, were informed about the purpose of the study, and dismissed. The entire testing session lasted approximately 50 min.

Materials and apparatus.

Modified composite letter task. The composite letter task (Navon, 1977) is generally used as a measure of the breadth of visual attention, and the modifications here adapt the task to also measure the flexibility of visual attention across different contexts. A given trial in this task was much like those used in previous studies. The composite letter stimuli consisted of large (global) letters comprised of several smaller (local) letters, for example, a large T made of smaller Fs. Before each trial, participants were instructed to indicate with a button press which of two target letters (T or H) was present in the stimulus. Exactly one of the two target letters was present in the upcoming stimulus, appearing at either the global or the local level, and on each trial there was an equal probability of a T or an H target. Distractor letters, making up the other component of the composite stimulus, were F and L. The height of the global letters subtended 3.34° and the width 1.91°, whereas the local letters had a height of 0.48° and a width of 0.32°. These viewing angles were achieved by placing the participants' chair approximately 60 cm from the computer monitor. Each trial consisted of a fixation cross (1 s) followed by the composite letter stimulus (2 s). Participants were instructed to make their responses as quickly and as accurately as possible.

The critical modifications to this task were done at the block level. Traditional versions of the composite letter task use a 50/50 ratio of global to local targets in each block of trials. Critically, in this modified version the ratio of global to local targets was varied by block to manipulate context. Specifically, each 32-trial block contained one of nine possible global-to-local ratios: 4/28, 7/25, 10/22, 13/19, 16/16, 19/13, 22/10, 25/7, and 28/4. The 16/16 block has the same ratio as those used in past studies, and all others represent evenly-spaced degrees of local or global bias. Within each block, the order of trials was pseudo-randomized to ensure a similar distribution of trial types throughout the block and that the block began with at least two trials of the dominant type to avoid primacy effects of the minority trial type. Participants completed two blocks of each condition for a total of 18 blocks and 576 trials across the experimental session. The blocks were organized into three runs with six blocks each and pseudo-randomized within each run, and the order of the runs was counterbalanced across participants.

Importantly, each trial in this task can be classified as either a switch trial or a non-switch trial. On switch trials, the target is not at the same level of focus as it was on the previous trial, so participants need to switch their focus of attention between the global and local levels. On non-switch trials, the target is at the same level of focus as it was on the previous trial, thus participants can maintain the same level of focus to respond to the target. By comparing reaction times (RTs) on switch versus non-switch trials across different block contexts, it is possible to assess whether attention-switching abilities changed based on the context.

Debriefing. A funneled debriefing (e.g., Chartrand & Bargh, 1996) was used to assess participants' awareness of the varying global–local context by block. Using this procedure, the experimenter verbally asked participants what they noticed about the task, beginning with vague, general questions, followed by more directed leading questions. Specifically, participants were first asked "Did you notice anything about the blocks of trials?"; this was followed by "Did you notice any differences between blocks of trials?"; lastly, they were asked "Did you notice that on some blocks there was an uneven ratio of big letter to small letter targets?" Finally, participants were asked to guess "how many of the 18 blocks they thought had an uneven ratio of big letter to small letter targets."

Questionnaire measures. Participants completed several questionnaire measures relevant to attentional breadth, which were included to control for individual differences in chronic level of attentional focus. The Systemizing Quotient questionnaire (SQ; Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003) measures an individual's tendency to analyze and construct systems ($\alpha = .91$). On this measure, participants indicate on a 4-point scale (*strongly agree*, *slightly agree*, *slightly disagree*, *strongly disagree*) the accuracy of 60 statements, including "When I learn a language, I become intrigued by its grammatical rules." Additionally, participants completed the Behavior Identification Form (BIF; Vallacher & Wegner, 1989), a 20-item questionnaire that measures individual differences in action identification along a concrete/abstract continuum ($\alpha = .85$). For example, participants indicate whether "Toothbrushing" is (a) "Preventing tooth decay" (more abstract), or (b) "Moving a brush around in one's mouth" (more concrete). These measures were included because of their relevance to individual differences in the tendency to adopt a global or local perspective. Additionally, we were interested in whether one's chronic level of attentional focus may relate to attentional flexibility, and whether, for example, having a higher level of chronic attentional focus may impact an individual's ability to switch his or her attentional focus.

Apparatus. The experimental task was run using eM's Stimulus Software (MSS; Falk, 2009) build on the Psychtoolbox for MATLAB. Stimuli were displayed on a computer screen with dimensions of 68 × 38.25 cm. Participants made responses using the G and H keys (for T and H, respectively) on a standard QWERTY keyboard.

Results and Discussion

Data from two participants were excluded because of an accuracy rate of less than 80%, which was chosen based on a histogram of accuracy rates across subjects, which showed a clear gap between those who performed at 80% accuracy or better and those who did not. Three other participants were excluded for having incomplete data, leaving a total of 44 participants included in the analyses. Among these participants, trials with incorrect responses, as well as those with reaction times (RTs) less than 100 ms, greater than the stimulus duration of 2,000 ms, and more than 3 standard deviations (*SD*s) outside of participants' mean RT for each condition (4.04% of all trials) were excluded from the final analyses. The 3-*SD* criterion was chosen as a conservative threshold for removing a small number of extreme outliers that could skew the data.

Switch costs were calculated for each participant as a measure of attentional switching abilities across contexts. In order to do this, each participant's RTs for trials of each type (switch and non-switch) were combined and averaged for each block type. Participants' mean non-switch RT was then subtracted from mean switch RT for each block, giving a measure of switch cost for each block type. A larger switch cost indicates a greater amount of time required to switch between global and local levels of attentional focus, and thus less attentional flexibility.

The data were analyzed using a repeated-measures analysis of variance (ANOVA) with context as a within-subjects factor with nine levels and switch cost as the dependent measure. The assumption of equal variances across conditions was not met, so the Greenhouse–Geisser corrected degrees of freedom are reported here. The analysis showed a significant main effect of block bias, $F(5.65, 243.02) = 15.42$, $p < .001$, $\eta_p^2 = .26$. A polynomial contrast demonstrated that the pattern of results is best summarized with a quadratic function, $F(1, 43) = 77.40$, $p < .001$, $\eta_p^2 = .64$. As shown in Figure 1, switch costs tend to increase with the degree

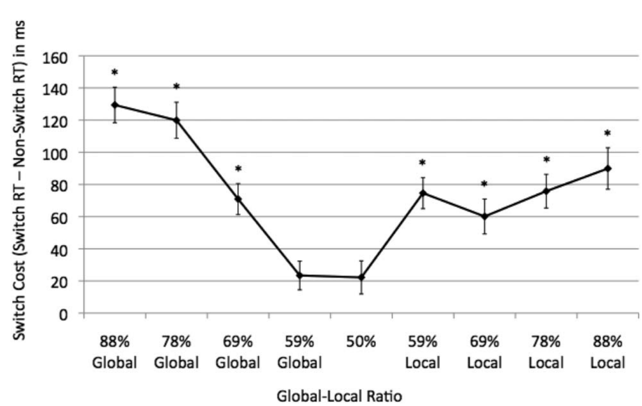

Figure 1. Study 1: Switch costs as a function of global–local block context. Error bars represent ±1 *SE*, and asterisks represent conditions in which switch costs were significantly different from the 50% global/50% local condition. Switch costs had a U-shape: They were smallest on evenly proportioned blocks (50% global, 50% local) and increased as the block's global–local context became more uneven. RT = reaction time.

of unbalance in a block, and are lowest when there is an even number of global and local targets in a block, creating a U-shaped pattern. Planned contrasts demonstrated that switch costs differed significantly from the even condition (16/16) in all other conditions except the 19 global/13 local condition, Fs(1, 43) > 7.96, ps $< .007$, $.57 \geq \eta_p^2$s $\geq .16$. This pattern of results across the different block contexts makes intuitive sense. On even blocks, global and local trials were highly intermixed, and switches were frequent, thus participants may have been more prepared to respond to switches. Conversely, the greater the degree of unevenness in a block, the more instances of long runs of a certain trial type, and the fewer switch trials. On these uneven blocks, participants may have fallen into a pattern of responding to the most prevalent target type, and when a switch occurred, they were less prepared to respond, resulting in slower attentional shifts.

Participants' responses to the debriefing questions were also examined to determine whether their attentional shifts occurred outside of awareness. Only one reported noticing changing contexts in response to the first and broadest question, "Did you notice anything about the blocks of trials?" No individuals mentioned noticing the varying global–local context across blocks in response to the next, slightly more specific question about "any differences between blocks of trials." Only when explicitly asked about "an uneven ratio of big letter to small letter targets" did any participants indicate that they noticed ($n = 14$). Thirty-one said they did not. Participants who noticed the context change guessed, on average, that 8.86 of the blocks had an uneven ratio ($SD = 3.98$), which was significantly less than 16, the actual number of blocks with an uneven ratio, $t(13) = -6.72$, $p < .001$. In order to determine whether the observed switch cost effects were driven by participants who noticed a varying context, another repeated measures ANOVA was run with the "noticing" participants excluded. This analysis revealed the same results as the previous one, with a significant main effect of block context, $F(4.91, 142.25) = 10.51$, $p < .001$, $\eta_p^2 = .27$, and a significant quadratic trend, $F(1, 29) = 44.27$, $p < .001$, $\eta_p^2 = .60$. The planned contrasts also showed the same results as those that included the full sample, with one exception: Switch costs in the 10 global/22 local condition was not significantly different than the even condition, $F(1, 29) = 1.82$, $p = .19$, $\eta_p^2 = .06$.

We note that most participants who did notice a changing context mentioned it only after somewhat leading questions. This fact, along with the replication of the main findings among only those participants who did not notice the varying global–local context even under direct questioning, suggests that task performance was not likely to have been guided by explicit awareness of the block bias. Furthermore, it is noteworthy that two thirds of participants did not report noticing the varying contexts even when directly questioned about them. This finding is especially interesting given that some blocks had an extremely unbalanced ratio (e.g., 4 global/28 local or vice-versa). Overall, it seems likely that the observed behavioral results were not driven by participants making conscious decisions to change their preparedness to shift attention, but rather by an automatic adaptation based on the context of the block.

BIF and SQ scores were not significantly correlated with switch costs in any of the conditions, and thus are not discussed further, and were not included in subsequent studies.

Overall, Study 1 demonstrated that individuals' ability to shift between global and local attention does change as a function of the context. Participants tend to be best at switching when there is an equal proportion of global to local trials, and switches become more time-consuming as block contexts become more unbalanced. Furthermore, most participants did not notice the changing global–local contexts by block, possibly because the participants were focused on the primary task of finding and identifying the target letter. These results suggest that this task could be a useful and valid tool for studying automatic shifts in attentional flexibility as a function of context and motivational state. In the subsequent studies, this U-shaped context effect will be compared to the context effect when participants are in different motivational states.

Study 2

Study 2 examined the influence of approach and avoidance motivation on the malleability of attentional breadth. To this end, participants completed the varying-context composite letter task while approach, avoidance, and neutral motivational states were induced. In order to ensure the induction of sufficiently strong motivational states, a dual motivation manipulation procedure was used. Although past studies (e.g., Gable & Harmon-Jones, 2008, 2010a) have shown that high-intensity motivational states of both approach and avoidance directions narrow attention, we are interested in whether they may differentially affect individuals' ability to shift their attentional focus between global and local levels.

Method

Participants. Participants were 51 undergraduate students (mean age = 19.90 years, $SD = 2.96$, range = 18–39) at the University of Oregon who received partial course credit. All participants gave informed consent before taking part in the study.

Procedure. The experimental procedure was similar to that for Study 1. After giving informed consent, participants were instructed on the composite letters task, and completed eight practice trials with neutral images. Next, participants completed the experimental task, completed a brief questionnaire measure, and were verbally debriefed. Participants were then informed about the purpose of the study and dismissed. Overall, the testing sessions lasted approximately 1 hr.

Materials and apparatus.

Motivation manipulation and modified composite letter task. The task used here was similar to the one used in Study 1, but with a few key changes. First, participants' motivational states were manipulated within-subjects using both embodied motivational cues (arm positions) and motivationally relevant images.

For the embodiment manipulation, participants learned two arm positions that would be used throughout the task, and were informed that the experiment was assessing how different body positions influence cognitive processes. In the "pull toward you" (approach) position, participants put their hand underneath the desk in front of them with their palms up and exerted pressure upward on the desk. In the "push away from you" (avoidance) position, participants placed their hand on top of the desk with their palms down and exerted pressure downward on the desk. Participants were instructed to use the same amount of pressure for the pull and push positions, and to try to maintain a constant amount of pressure over the course of the experiment. There was also a neutral arm condition, in which participants were told to place their arm in a comfortable position, and to avoid exerting pressure in any direction. Arm positions were carried out with participants' non-dominant arms, while their dominant hands responded to trials using the keyboard. Before each block of trials began, a message would inform them which hand position to assume for the duration of the block.

To supplement this embodiment manipulation, participants viewed a motivationally relevant image before each trial of the composite letter task. On approach blocks, the pictures were of highly craved foods (e.g., chocolate cake); on avoidance blocks, they were of insects and rotting food; and on neutral blocks, they were of non-emotional objects (e.g., light switch, filing cabinet). The motivational valence of the images was always concordant with that of the arm positions (e.g., approach images always paired with approach arm position). Approach and avoidance stimulus sets each included 96 images used in previous experiments (Berkman & Lieberman, 2010; Giuliani, Calcott, & Berkman, 2013) as well as images from the International Affective Picture System (IAPS). The neutral images were selected from the IAPS and were supplemented with similar images found using the Google search engine. In order to ensure that the approach and avoidance images were matched for intensity, pleasantness and unpleasantness ratings from the previous studies were converted into a common scale and compared. There was no significant difference in the distance from the midpoint of the scale between the approach and avoidance images, $t(97.7) = 1.32$, $p = .190$, using a Greenhouse–Geisser correction. Participants viewed each picture twice over the course of the experiment in different conditions.

With the addition of the images, the trial timing for the composite letter task was slightly changed in this experiment. Each trial began with a fixation cross for 1 s, followed by the motivation-inducing image for 750 ms, a fixation cross for another 500 ms, and the composite letter stimulus for 1.5 s. The display time for the composite letter stimuli was reduced from 2 s in Study 1 because participants typically responded much faster than 1.5 s, and the reduction allowed us to decrease the total task time for Study 2.

Participants completed this modified task in blocks of 32 trials with three different global–local ratios to manipulate context: 24/8, 16/16, and 8/24. The 8/24 ratio was chosen because of its similarity to the 7/25 ratio used in Study 1, which was the least biased ratio that was consistently different from the 50/50 condition in both the local and global directions. The experiment used a 3 (context: mostly global/even/mostly local) $\times$ 3 (motivation: approach/neutral/avoidance) within-subjects design, yielding a total of nine conditions. All participants completed two blocks of each condition, for a total of 18 blocks and 576 trials across the experimental session. As in Study 1, the blocks were presented in pseudo-randomized order in three counterbalanced runs. Following each block, there was a 12-s break, during which time the screen instructed participants to "Please wait." This rest was included to reduce motivational carryover effects across blocks.

Debriefing. Because the motivation-inducing positions and images could increase the likelihood of demand characteristics, an additional question was added to the verbal debriefing to probe for knowledge of study hypotheses. Participants were asked, "If you had to guess, what do you think this experiment is about?"

Questionnaire measure. Participants completed the Behavioral Activation and Behavioral Inhibition scales (BIS/BAS; $\alpha =$ .76; Carver & White, 1994), which measure individual differences in the sensitivity of approach and avoidance motivational systems, respectively. Participants indicated on a 5-point scale (*Strongly Disagree*, *Disagree*, *Neutral*, *Agree*, *Strongly Agree*) the extent to which they agree with 20 statements. The BIS scale contains seven items, including "I worry about making mistakes." The BAS scale is divided into three subscales: reward responsiveness (five items; "When I get something I want, I feel excited and energized"), drive (four items; "When I want something, I usually go all-out to get it"), and fun seeking (four items; "I crave excitement and new sensations"). This measure was included because of its relevance to individual differences in the tendency to experience approach and avoidance states, which may in turn influence the effects of these states on attentional processes.

Apparatus. The experimental set-up and apparatus were the same as those used in Study 1.

Results and Discussion

Before further analysis, five participants were excluded for having an accuracy rate below 80%, and an additional three participants were excluded because of missing data, leaving a total of 43 participants. The data were also cleaned to remove incorrect trials and those with RTs less than 100 ms, greater than the stimulus duration of 1,500 ms, as well as those with RTs more than 3 *SD*s away from participants' mean RT for each condition (5.43% of all trials).

Switch costs. As in Study 1, switch costs were calculated by subtracting mean RTs on non-switch trials from mean RTs on switch trials for each condition. The switch costs were then analyzed in a 3 (block context: mostly global, even, mostly local) $\times$ 3 (motivation: approach, neutral, avoidance) repeated measures ANOVA. There were significant main effects of block context, $F(2, 84) = 9.82$, $p < .001$, $\eta_p^2 = .19$, and motivation, $F(2, 84) = 8.00$, $p = .001$, $\eta_p^2 = .16$, and these main effects were qualified by a significant Context $\times$ Motivation interaction, $F(4, 168) = 3.97$, $p = .004$, $\eta_p^2 = .086$. As shown in Figure 2, the effect of motivation on switch costs differed, depending on the block context.

In order to better characterize the results for the different motivation conditions, the pattern of switch costs across contexts was compared to the U-shaped trend found in Study 1. Specifically, post hoc contrasts compared switch costs in the even blocks to those in the uneven blocks for each motivation condition. Both avoidance and neutral states led to significantly greater switch costs on unevenly proportioned blocks compared to even blocks: for avoidance, $F(1, 42) = 19.87$, $p < .001$, $\eta_p^2 = .32$; for neutral, $F(1, 42) = 19.94$, $p < .001$, $\eta_p^2 = .32$. Although avoidance and neutral showed similar patterns of results across contexts, switch costs were significantly lower in the avoidance condition overall compared to neutral, $F(1, 42) = 7.93$, $p = .007$, $\eta_p^2 = .16$. Interestingly, switch costs in the approach condition diverged from this pattern, as there was no significant difference in switch costs when comparing uneven and even block types, $F(1, 42) = 1.35$, *ns*, $\eta_p^2 = .03$. Upon closer examination of the data, however, a contrast directly comparing switch costs on even versus mostly local blocks

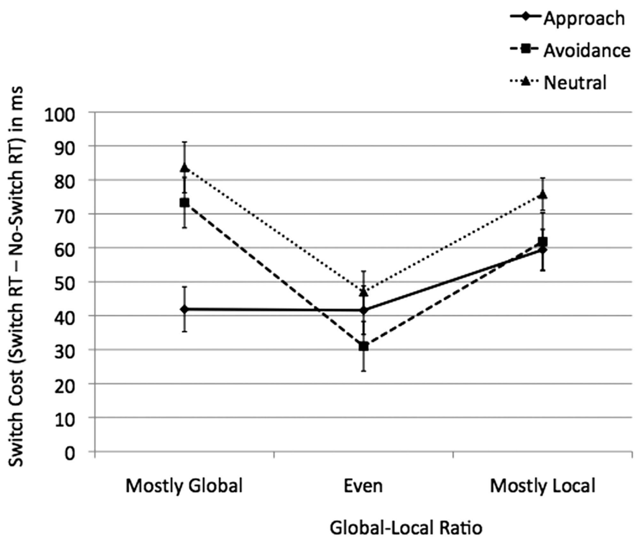

Figure 2. Study 2: Switch costs as a function of different global–local block contexts in three motivation conditions (approach, avoidance, neutral), which were manipulated using a combination of valenced images and motivationally relevant arm positions. Error bars represent ±1 *SE*. Avoidance and neutral conditions showed a similar pattern of results, with greater switch costs on uneven blocks (mostly global and mostly local) than on even blocks. In the approach condition, there was no difference in switch costs between even and uneven blocks; however, when switch costs in the even condition were directly contrasted with the mostly local condition, the difference was significant. RT = reaction time.

in the approach condition showed that switch costs were greater on mostly local blocks, $F(1, 42) = 4.35$, $p = .043$, $\eta_p^2 = .09$.

Post hoc contrasts also compared the switch costs in each motivation condition within the different block contexts. On even blocks, there were no significant differences in switch costs between the approach and avoidance conditions, $F(1, 42) = 1.22$, *ns*, $\eta_p^2 = .03$, or between the approach and neutral conditions, $F(1, 42) = 0.40$, *ns*, $\eta_p^2 = .01$; however, the avoidance condition did show smaller switch costs compared to neutral, $F(1, 42) = 3.99$, $p = .05$, $\eta_p^2 = .09$. On mostly global blocks, by contrast, the approach condition showed significantly lower switch costs than the avoidance and neutral conditions, $F(1, 42) = 21.49$, $p < .001$, $\eta_p^2 = .34$, which did not differ significantly, $F(1, 42) = 1.79$, $p = .19$, $\eta_p^2 = .04$. On mostly local blocks, switch costs did not differ significantly between approach and avoidance conditions, $F(1, 42) = 0.05$, *ns*, $\eta_p^2 < .01$, which together had smaller switch costs than the neutral condition, $F(1, 42) = 6.33$, $p = .02$, $\eta_p^2 = .13$. Thus, although approach motivation reduces switch costs in mostly global contexts, they do not necessarily facilitate switching across all situations.

Reaction time. Based on the data presented in Figure 2, it appears that motivational state interacts with context. Whereas approach led to lower switch costs on global blocks, avoidance and neutral led to higher switch costs in global contexts. However, switch costs are a relative metric and therefore do not indicate on their own whether the observed effects are being driven by changes in switch RTs, in non-switch RTs, or in both. To determine the relative contribution of switch and non-switch trials to the findings, we ran 2 (block context: mostly global, mostly local) × 3 (motivation: approach, neutral, avoidance) repeated measures ANOVAs on mean switch RTs and non-switch RTs separately. If the interaction between context and motivation was significant for switch RTs but not for non-switch RTs, it would demonstrate that the observed effects are being driven by motivation-related changes in switching abilities. The analysis of switch RTs had significant main effects of context, $F(1, 42) = 7.95$, $p = .007$, $\eta_p^2 = .16$, and motivation, $F(2, 84) = 24.11$, $p < .001$, $\eta_p^2 = .37$, as well as a significant interaction effect, $F(1.71, 71.84) = 4.95$, $p = .013$, $\eta_p^2 = .11$. By contrast, the analysis of non-switch RTs showed significant main effects of context, $F(1, 42) = 7.74$, $p = .008$, $\eta_p^2 = .16$, and motivation, $F(2, 84) = 8.66$, $p < .001$, $\eta_p^2 = .17$, but no significant interaction, $F(2, 84) = 1.00$, *ns*, $\eta_p^2 = .02$. Thus, changes in RT to switch trials, rather than non-switch trials, account for the observed interaction between context and motivation in the switch cost analysis (see Figure 3).

The next step in understanding the observed asymmetrical pattern is to look at the contributions of different types of switch trials (e.g., local-to-global vs. global-to-local switches). To address this question, RTs for local-to-global and global-to-local switch trials were examined separately in 3 (context) × 3 (motivation) repeated measures ANOVAs. By examining RTs on different types of switches, it is possible to determine whether the influence of motivation was limited to a specific target type, or whether the improved switching was generalized across all target types. The full four-factor ANOVA including non-switch trials was not possible, because some of the cells would have too few observations. However, it was possible to look at switch trials because the number of both switch types in each block was roughly equivalent. On trials with a local-to-global switch, there were significant main effects of context, $F(2, 84) = 90.56$, $p < .001$, $\eta_p^2 = .68$, and motivation, $F(2, 84) = 4.73$, $p = .011$, $\eta_p^2 = .10$, but no interaction, $F(2.69, 113.10) = 1.08$, *ns*, $\eta_p^2 = .03$. On the other hand, global-to-local switch trials showed main effects of context, $F(2, 84) = 30.01$, $p < .001$, $\eta_p^2 = .42$, and motivation, $F(2, 84) = 29.94$, $p < .001$, $\eta_p^2 = .68$, as well as a significant interaction effect, $F(3.02, 126.73) = 3.44$, $p = .019$, $\eta_p^2 = .08$. From these data, it appears that the interaction between context and motivation is being driven largely by global-to-local switch trials. Figure 4

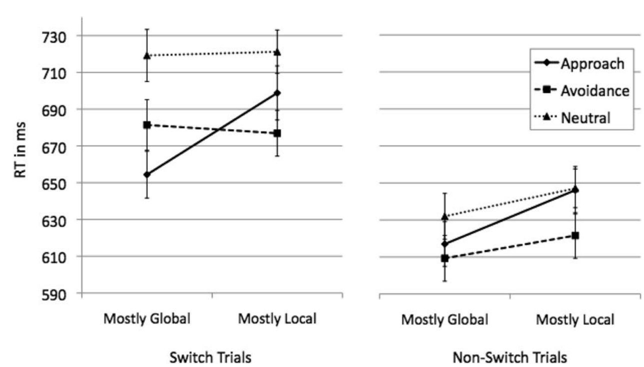

Figure 3. Study 2: Reaction times (RTs) for switch and non-switch trials separately, across two of the contexts (mostly global, mostly local) and three motivation conditions (approach, avoidance, neutral). Error bars represent ±1 *SE*. There was a significant interaction between context and motivation for switch trials but not for non-switch trials, indicating that switch RTs may be driving the observed switch cost effects.

illustrates the contrasting pattern of results between the two switch types.

The BIS/BAS scores did not show a consistent pattern of correlation with switch costs or RTs after adjusting for multiple comparisons, and were thus not examined further.

Overall, this study suggests that the effects of motivation on attentional flexibility vary depending on the context. When in an avoidance or neutral state, participants' switch costs were smaller on even blocks and larger on uneven blocks. As revealed by follow-up analyses, this pattern emerged because in these states, participants' ability to switch to a type of target was related to the prevalence of that type of target. That is, when the proportion of global targets decreased, they became slower at switching to global targets, and this finding also held for local targets. This finding resembles the results of Study 1 and suggests that an avoidance state facilitates responding in a patterned or repetitive way, which interferes with the ability to switch when switches are uncommon. In the approach condition, a different pattern emerged. On mostly global blocks in particular, participants switched just as efficiently as on even blocks when in an approach state. This effect was driven by a relatively enhanced ability to switch to local targets in mostly global contexts.

Study 3

Study 2 suggests that approach and avoidance motivation, induced using appetitive and aversive images in combination with embodied arm positions, have different effects on attentional flexibility across contexts. The dual motivation manipulation procedure was used in an effort to elicit robust motivational states; however, it may have also obscured important differences between the two procedures. In previous studies using the Navon letter task, embodiment cues and motivationally relevant images have produced different effects on attentional breadth (e.g., Friedman & Förster, 2000; Gable & Harmon-Jones, 2008). It has also been argued that images of food induce higher arousal approach states than do embodiment cues, and this difference may have consequences for motivation-induced attentional changes (Harmon-Jones, Gable, & Price, 2011). In order to disentangle the effects of these two motivation induction procedures on the findings, it is necessary to also examine their effects in isolation. In Study 3, we sought to replicate these findings using only images to evoke motivational states. By using images alone, we can also rule out the possibility that the effects in Study 2 can be explained by non-motivational factors, such as different levels of effort required in different motivation conditions. We expected that, as in Study 2, avoidance motivation would lead to greater switch costs on uneven blocks compared to even blocks, whereas approach motivation would lead to switch costs that are less variable across block types.

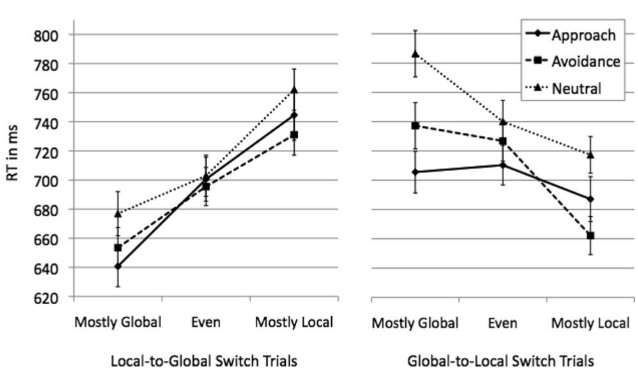

Figure 4. Study 2: Reaction times (RTs) for local-to-global and global-to-local switches separately, across three contexts (mostly global, even, mostly local) and three motivation conditions (approach, avoidance, neutral). Error bars represent ±1 *SE*. There was a significant interaction between context and motivation for global-to-local switches but not for local-to-global switches. Motivation differentially affected switching abilities across contexts only when switching to respond to a local target.

Method

Participants. Fifty-one undergraduate students (mean age = 20.31 years, $SD = 2.87$, range = 18–34) participated for partial course credit. All participants gave informed consent under the approval of the Committee for the Protection of Human Subjects at the University of Oregon.

Procedure, materials, and apparatus. The procedure, materials, and experimental protocol were the same as those used in Study 2, except that there was no embodiment manipulation. Instead, the category of motivationally-relevant images (approach, avoidance, neutral) preceding each trial was the only difference between the different motivation conditions.

Results and Discussion

Data from six participants were excluded for having low accuracy (<80%), and three participants were excluded for having incomplete data, leaving a total of 42 participants in the final analyses. Incorrect trials, and trials with RTs less than 100 ms, greater than 1,500 ms, as well as those that were more than 3 *SD*s away from the participants' mean RT for each condition were excluded from further analyses (5.15% of all trials).

Switch costs. The switch cost data were analyzed using a 3 (block context) × 3 (motivation) repeated measures ANOVA. The motivation term did not meet the assumption of equal variances, so the Greenhouse–Geisser degrees of freedom are reported here. There were significant main effects of both block context, $F(2, 82) = 17.83$, $p < .001$, $\eta_p^2 = .30$, and motivation, $F(1.74, 71.36) = 4.75$, $p = .011$, $\eta_p^2 = .10$; however, these main effects must be examined with respect to the significant interaction effect, $F(4, 164) = 7.87$, $p < .001$, $\eta_p^2 = .16$. As shown in Figure 5, the pattern of results for switch costs again differs markedly between the approach condition and the neutral and avoidance conditions. Planned contrasts were carried out to compare these findings to those of Study 2. Both the neutral and avoidance conditions showed a similar pattern of results, in which there were significantly greater switch costs on uneven blocks (mostly global and mostly local) compared to even blocks: for avoidance, $F(1, 41) = 38.49$, $p < .001$, $\eta_p^2 = .48$; for neutral, $F(1, 41) = 17.31$, $p < .001$, $\eta_p^2 = .30$. By contrast, there were no significant differences in switch costs between any of the block types in the approach condition: for mostly global versus even, $F(1, 41) = 0.20$, *ns*, $\eta_p^2 < .01$; for even versus mostly local, $F(1, 41) = 2.21$, $p = .15$, $\eta_p^2 = .05$; and for mostly global versus mostly local, $F(1, 41) = 2.54$, $p = .12$, $\eta_p^2 = .06$. Thus, in an approach state, participants were equally proficient at switching across all block types.

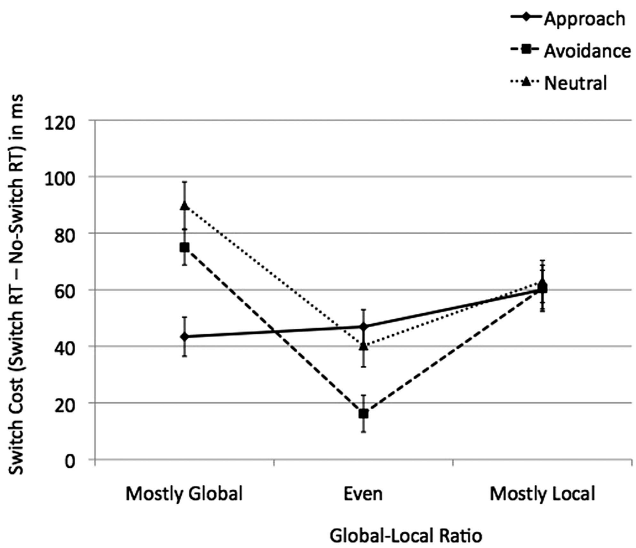

Figure 5. Study 3: Switch costs as a function of different global–local block contexts in three motivation conditions (approach, avoidance, neutral), which were manipulated using only motivationally relevant images. Error bars represent ±1 *SE*. In the avoidance and neutral conditions, participants had greater switch costs on uneven blocks (mostly global and mostly local) than on even blocks. In the approach condition, there was no significant difference in switch costs between even and uneven blocks. RT = reaction time.

This pattern replicates the findings of Study 2 and suggests that in a neutral or avoidance state, participants become accustomed to attending the level of the most prevalent target type on unevenly-proportioned blocks (e.g., responding to global targets on mostly global blocks), and thus switches to the less prevalent target type are slowed. On even blocks, however, switches are more likely, and so participants do not become as entrenched in a certain response pattern, and switches are less costly. On the other hand, when in an approach state, people do not become entrenched in a particular level of attentional breadth, even when it is most prevalent mode of attention in the context.

It should be noted that approach did not impart greater flexibility across all contexts. Post hoc contrasts showed that in this study, avoidance led to significantly lower switch costs on even blocks compared to both approach and neutral, $F(1, 41) = 11.21$, $p = .002$, $\eta_p^2 = .22$. The results trended in this direction in Study 2 though the contrast in that study did not reach significance. In agreement with Study 2, approach motivation reduced switch costs on global blocks compared to avoidance and neutral blocks, $F(1, 41) = 30.26$, $p < .001$, $\eta_p^2 = .43$. Unlike in Study 2, there were no differences in switch costs across motivation conditions in mostly local contexts, $Fs(1, 41) < 0.12$, *ns*, $\eta_p^2s < .01$. Overall, however, the absolute differences in switch costs across motivation conditions in this study were consistent with those of Study 2.

Reaction time. In order to determine whether the switch cost effect resulted from the same underlying change specifically on global-to-local switches in approach states, the same follow-up analyses from Study 2 were carried out. When mean RTs for switch and non-switch trials were pooled and analyzed separately, a similar pattern of results emerged. On switch trials, there was a significant main effect of motivation, $F(2, 82) = 3.17$, $p = .05$, $\eta_p^2 = .07$, and a significant interaction, $F(2, 82) = 6.67$, $p = .002$, $\eta_p^2 = .14$, such that approach led to faster RTs on switch trials in mostly global contexts and slower RTs in mostly local contexts, whereas avoidance and neutral showed the opposite pattern. The main effect of context was not significant, $F(1, 41) = 0.01$, *ns*, $\eta_p^2 < .01$. On non-switch trials, by contrast there was no significant interaction, $F(2, 82) = 0.48$, *ns*, $\eta_p^2 = .01$. Here, too, the main effect of motivation reached significance, $F(2, 82) = 3.60$, $p = .03$, $\eta_p^2 = .08$, whereas the main effect of context did not, $F(1, 41) = 1.67$, *ns*, $\eta_p^2 = .04$. The contrast between RTs for switch and non-switch trials is shown in Figure 6. The fact that there was a Context × Motivation interaction only on switch trials replicates the findings of Study 2.

Next, repeated measures ANOVAs examined the effects of context and motivation on mean local-to-global and global-to-local switch RTs separately. As found in Study 2, there was no significant interaction between motivation and context for local-to-global switches, $F(2.95, 121.11) = 1.11$, *ns*, $\eta_p^2 = .03$. There was a significant main effect of context, $F(2, 82) = 44.64$, $p < .001$, $\eta_p^2 = .52$, but no effect of motivation, $F(2, 82) = 0.51$, *ns*, $\eta_p^2 = .01$. As shown in Figure 7, all motivational conditions led to equivalent performance on local-to-global switches across all three contexts. However, for global-to-local switches, the interaction was significant, $F(3.15, 129.23) = 5.58$, $p = .001$, $\eta_p^2 = .12$. There were also significant main effects of context, $F(2, 82) = 70.19$, $p < .001$, $\eta_p^2 = .63$, and motivation, $F(2, 82) = 6.55$, $p = .002$, $\eta_p^2 = .14$. The general finding that the interaction was significant only for global-to-local switches is consistent with the findings of Study 2. In fact, the effect size became even larger for Study 3, suggesting that this global-to-local asymmetry is an important point of differentiation between approach and avoidance motivational states.

Study 4

Studies 2 and 3 are highly consistent in their findings that approach and avoidance lead to different patterns of attentional flexibility. However, it is worth noting that both studies used

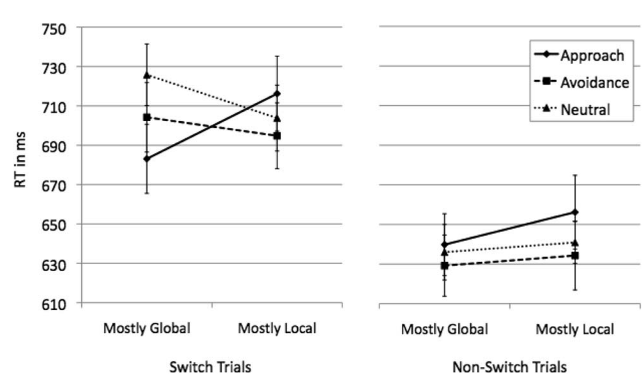

Figure 6. Study 3: Reaction times (RTs) for switch and non-switch trials separately, across two of the contexts (mostly global, mostly local) and three motivation conditions (approach, avoidance, neutral). Error bars represent ±1 *SE*. Consistent with Study 2, there was a significant interaction between context and motivation for switch trials but not for non-switch trials.

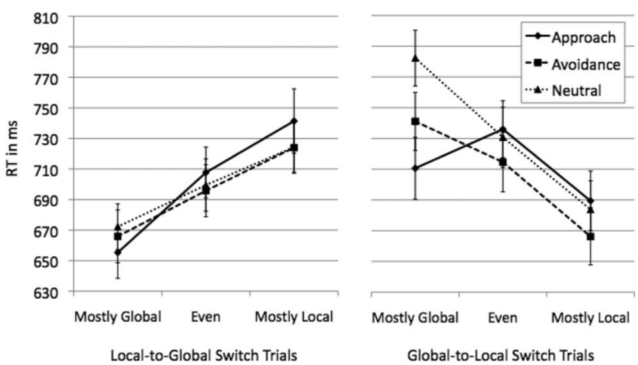

Figure 7. Study 3: Reaction times (RTs) for local-to-global and global-to-local switches separately, across three contexts (mostly global, even, mostly local) and three motivation conditions (approach, avoidance, neutral). Error bars represent ± 1 *SE*. Consistent with Study 2, there was a significant interaction between context and motivation for global-to-local switches but not for local-to-global switches. Differences between motivation conditions emerge for switching to local targets on mostly global blocks.

emotional pictures to induce approach and avoidance states. Thus, we cannot determine whether these findings are a result of motivation per se, or if they are instead caused by an emotional, rather than purely motivational state. Study 4 was conducted to determine whether the same results would be found when motivation was manipulated in the absence of emotion, using embodied motivational cues.

Method

Participants. Participants were 50 undergraduate students who earned a course credit (mean age = 20.06 years, *SD* = 5.40, range = 18–56).

Procedure, materials, and apparatus. The procedure, materials, and apparatus were the same as those used in Study 3, except that motivational states were induced using only embodied motivational cues (arm flexion vs. extension). The motivational picture stimuli were completely absent from this study, thus the trial length was shortened. Each trial consisted of a fixation cross for 1 s, which was followed by the composite letter stimulus, which was displayed for 1.5 s.

Results and Discussion

Prior to data analysis, two participants were excluded because of technical issues encountered during their session, and two were excluded for having low accuracy (<80%), leaving 46 participants in the final analyses. The data were cleaned as in the previous studies by removing trials with incorrect responses as well as those with outlying RTs (3.45% of all trials).

Switch costs. Switch costs were analyzed in the same manner as previous studies. Similar to the previous studies, there were significant main effects of block context, $F(2, 90) = 18.83$, $p < .001$, $\eta_p^2 = .30$, motivation, $F(2, 90) = 4.77$, $p = .01$, $\eta_p^2 = .10$, and a significant interaction, $F(4, 180) = 3.74$, $p = .006$, $\eta_p^2 = .08$. As shown in Figure 8, the switch costs closely resemble those from Studies 2 and 3. Planned contrasts explored this interaction by comparing switch costs on even blocks to those on even blocks for each motivation condition. The avoidance and neutral conditions showed the familiar pattern of having significantly greater switch costs on uneven compared to even blocks: for avoidance, $F(1, 45) = 34.79$, $p < .001$, $\eta_p^2 = .44$; for neutral, $F(1, 45) = 13.55$, $p = .001$, $\eta_p^2 = .23$. In the approach condition, the difference in switch costs across block contexts did not reach significance; however, it was closer than it has been in previous studies, $F(1, 45) = 2.87$, $p = .09$, $\eta_p^2 = .06$.

The absolute differences in switch costs across motivation conditions closely resembled those found in Study 3. Avoidance motivation led to reduced switch costs on even blocks compared to approach and neutral, $F(1, 45) = 7.59$, $p = .008$, $\eta_p^2 = .14$. On mostly global blocks, approach led to smaller switch costs than avoidance and neutral, $F(1, 45) = 17.36$, $p < .001$, $\eta_p^2 = .28$. There was no difference in switch costs across motivational states in the mostly local condition, $Fs(1, 45) < 0.88$, *ns*, η_p^2s $\leq .02$.

These findings are consistent with those of Studies 2 and 3. Of note is that in this study, there was a marginally significant difference in switch costs between even and uneven blocks in the approach condition, whereas in previous studies there was no significant difference. However, the effects of approach motivation on attentional flexibility were in the same direction as they were in Studies 2 and 3.

Reaction time. As in Studies 2 and 3, mean switch and non-switch RTs were examined in separate 2 (context) × 3 (motivation) repeated-measures ANOVAs. Here, in contrast to the previous studies, there was a significant interaction between context and motivation for non-switch trials, $F(1.62, 72.89) = 4.41$,

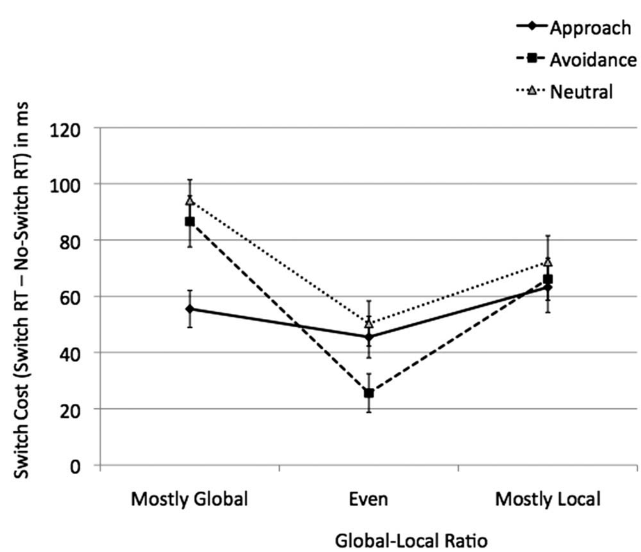

Figure 8. Study 4: Switch costs as a function of different global–local block contexts in three motivation conditions (approach, avoidance, neutral), which were manipulated using motivationally relevant arm positions. Error bars represent ± 1 *SE*. In the avoidance and neutral conditions, participants had greater switch costs on uneven blocks (mostly global and mostly local) than on even blocks. In the approach condition, there was no significant difference in switch costs between even and uneven blocks; however, when switch costs in the even condition were directly contrasted with the mostly local condition, the difference was significant. RT = reaction time.

p = .015, η_p^2 = .09. There was also a significant main effect of motivation, $F(2, 90) = 6.45$, $p = .002$, $\eta_p^2 = .13$, and a marginally significant effect of context, $F(1, 45) = 3.99$, $p = .052$, $\eta_p^2 = .08$. The analysis of switch RTs also demonstrated a main effect of motivation, $F(2, 90) = 7.67$, $p = .001$, $\eta_p^2 = .15$, as well as a significant interaction, $F(2, 90) = 7.72$, $p = .001$, $\eta_p^2 = .15$. The main effect of context was not significant, $F(2, 90) = 0.074$, *ns*, $\eta_p^2 = .002$. As illustrated in Figure 9, these RT findings show some important similarities with those of the previous two studies. The interaction between context and motivation was significant for switch trials, demonstrating that changes in switch RTs do account for some of the context-motivation interaction for switch costs. On the other hand, the existence of a significant interaction in the analysis of non-switch RTs was inconsistent with the findings of Studies 2 and 3. It is worth noting, however, that the effect size of the interaction was greater for switch trials (.15) than for non-switch trials (.09).

To better understand the observed interaction on the switch trials, separate repeated measures ANOVAs were carried out for local-to-global and global-to-local switches across all three contexts and motivation conditions. For local-to-global switches, there was a significant main effect of context, $F(2, 90) = 34.05$, $p < .001$, $\eta_p^2 = .43$, and a marginally significant interaction between motivation and context, $F(3.03, 136.27) = 2.30$, $p = .06$, $\eta_p^2 = .05$. The main effect of motivation was not significant, $F(2, 90) = 1.17$, *ns*, $\eta_p^2 = .03$. Although the interaction approached significance, it is worth noting the high degree of similarity in the pattern of the results (see Figure 10) to those of Studies 2 (see Figure 4) and 3 (see Figure 7), albeit with slightly more variation between the motivation conditions across contexts. Consistent with previous studies, analysis of global-to-local switch RTs revealed significant main effects of context, $F(2, 90) = 28.39$, $p < .001$, $\eta_p^2 = .39$, and motivation, $F(2, 90) = 14.52$, $p < .001$, $\eta_p^2 = .24$, as well as a highly significant interaction term, $F(4, 180) = 7.55$, $p < .001$, $\eta_p^2 = .14$ (see Figure 10). As in Studies 2 and 3, although both types of switches showed at least a marginally significant interaction between context and motivation, the global-to-local switch had a smaller p value and a larger effect size.

As mentioned above, the small number of observations in some conditions made it impossible to carry out a similar analysis to determine which type of non-switch trials drove the interaction effect among those trials. On the other hand, because of extremely small numbers of non-switch global trials on mostly local blocks, we can be fairly certain that these effects were caused by changes in the speed of responding to non-switch local targets on mostly local blocks.

Overall, the results of Study 4 were consistent with the previous studies (though with some discrepancies as noted above) and overall lower levels of statistical significance. One possible explanation for this pattern is that the motivation induction was less potent for this experiment. The use of subconscious embodied motivational cues may have evoked weaker motivational states, which could have resulted in smaller effects and noisier data. Another possibility is that, in spite of instructions, participants did not exert equal amounts of pressure for approach and avoidance trials, resulting in unequal motivational intensity across conditions. Although not all of the effects were replicated in this final study, they were largely in the same directions and of similar magnitudes as those observed in Studies 2 and 3. Thus, it is likely that the observed effects are caused, at least in part, by different types of motivation, rather than by differences in subjectively felt emotions.

General Discussion

A series of studies examined the effects of approach and avoidance motivation on the flexibility of attentional breadth as those effects varied by task context. Study 1 demonstrated that, in the absence of a motivation induction, switch costs increase with the degree of global/local imbalance in a block of trials. That is, participants tended to switch their attentional focus less efficiently in contexts when one trial type is predominant and switches are

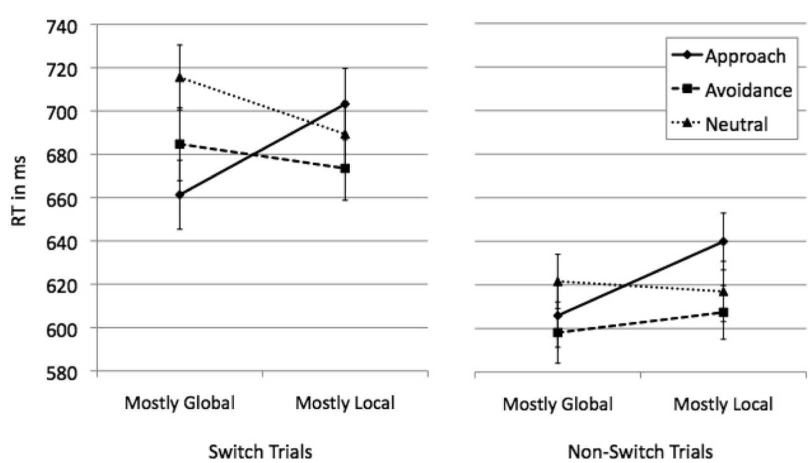

Figure 9. Study 4: Reaction times (RTs) for switch and non-switch trials separately, across two of the contexts (mostly global, mostly local) and three motivation conditions (approach, avoidance, neutral). Error bars represent ±1 *SE*. Unlike Studies 2 and 3, there was a significant interaction between context and motivation for both switch trials and non-switch trials. It is worth noting, however, that the effect size of the interaction was larger for switch trials, which is consistent with Studies 2 and 3.

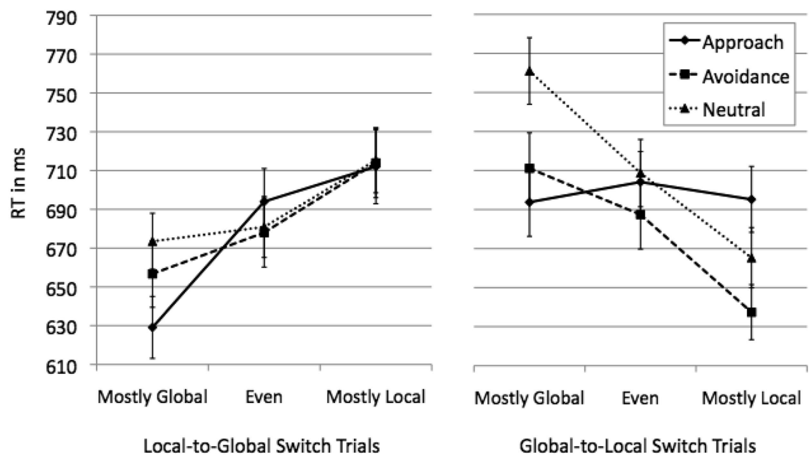

Figure 10. Study 4: Reaction times (RTs) for local-to-global and global-to-local switches separately, across three contexts (mostly global, even, mostly local) and three motivation conditions (approach, avoidance, neutral). Error bars represent ±1 *SE*. Diverging from Studies 2 and 3, there was a marginally significant interaction between context and motivation for local-to-global switches as well as the significant interaction for global-to-local switches. However, note the consistency in the overall shape of the plots (see Figures 4 and 7).

rare. This result established a novel version of the composite letter task with a varying ratio of local to global trials as a useful tool for measuring context-related attentional flexibility. Studies 2–4 demonstrated that the effects of motivation on attentional flexibility depend in a complex way on the context in which a trial is embedded. Overall, approach and avoidance manipulations both tended to increase flexibility, relative to a neutral condition; however, their specific influences differed across contexts. Approach motivation consistently led to reduced switch costs on mostly global blocks, whereas avoidance reduced switch costs on even blocks in two of three studies. Furthermore, whereas switch costs varied by block context following avoidance manipulation and in a neutral condition, the approach manipulation led to a “flat” switch cost profile indicative of a similar magnitude of switch costs regardless of block contexts. Subsequent analyses showed that the pattern observed in the approach condition occurred because of enhanced switching from global to local targets during mostly global blocks.

One interpretation of these findings is that approach and avoidance motivation both impart a degree of attentional flexibility but that the subtle differences between the two become apparent only when context is considered. In even contexts—when attentional switching is most frequent—avoidance appears to confer a slight advantage in attentional flexibility. On the other hand, when there is a global context and switching is more unusual, approach motivation may impart greater flexibility in responding to the infrequent switches to the local level. One potential explanation for this finding is that approach motivation may reduce reliance on a probabilistic rule, leading to attentional processing that can more quickly shift following unexpected events. It is important to note that this pattern of results emerged only on globally biased blocks, rather than across all different contexts.

One potential explanation for this asymmetry in the results is that the targets used in this task have an inherent attentional asymmetry—for most people, a global focus is the default level of focus (Navon, 1977). On mostly global blocks, this dominant level of attentional focus was encouraged, which may have led to habitual responding to these dominant, global targets. Upon encountering a rare local target, however, an approach state, unlike avoidance or neutral states, allowed participants to overcome this dominant response pattern and shift their attention to the local level more quickly. Conversely, on mostly local blocks, even though the context leads to habitual local attentional focus, it is possible that the ability to return to the dominant (global) level of focus was not differentially affected by the motivation manipulations.

Previous studies of motivation and attentional breadth have largely focused on understanding the direction of attentional biases in isolation from the broader situation. By instead examining attentional flexibility across situations, we demonstrated that the influence of motivational states on attentional breadth is context-dependent. The observed context-dependence arises because approach and avoidance motivation have different effects on attentional flexibility that vary by the task environment. These findings would not have become apparent without examining the role of context when considering the effects of motivation on attentional breadth.

In addition to underscoring the importance of context, these studies have found areas where approach and avoidance motivation may have divergent influences on attention. Past studies (e.g., Gable & Harmon-Jones, 2008, 2010a) have shown that pre-goal approach and avoidance states both induce attentional narrowing. This link between motivational intensity and attentional narrowing has been found consistently; however, it is important to note that those studies were conducted in one particular context, in which global and local attentional biases are equally beneficial to task performance. Another important difference between those studies and the ones reported here is that we did not systematically attempt to vary the level of motivational intensity (e.g., high vs. low intensity approach motivation). Although those studies demonstrated that approach and avoidance had similar effects on attentional breadth in even global–local contexts, it is possible that these effects emerged via different processes. That is, approach and avoidance may elicit the same "behavioral phenotype" when global and local biases are equally advantageous or when motivational intensity is high, even though the different motivational states may arrive at this mode of attentional focus through divergent underlying mechanisms. By varying the context of the task, then, we were able to discern situations in which approach and avoidance motivational states result in different effects on attention.

The notion that approach motivation may allow individuals to overcome a dominant pattern of responding agrees with the positive affect literature on flexibility (e.g., Isen & Daubman, 1984; Murray et al., 1990). Although we did not use the same dependent variable, this interpretation fits conceptually with the findings of Baumann and Kuhl (2005), who found that positive affect facilitates overcoming one's default level of attentional focus. Positive affect has also helped individuals overcome other dominant responses, as indicated by improved performance on a Stroop task (Kuhl & Kazén, 1999) and an antisaccade task (Van der Stigchel et al., 2011). Interestingly, the positive affective states evoked in these past studies typically were low in motivational intensity, whereas in our study, we aimed to evoke higher-intensity approach states. Although other studies have shown divergence in the cognitive consequences of high- and low-approach states, it is possible that by also examining context, we were able to find a point of convergence.

An examination of context may also help explain some of the discrepant findings in the studies on motivation and attentional flexibility. The finding here that avoidance motivation reduced switch costs in even contexts is consistent with Koch et al.'s (2008) finding that avoidance motivation increased flexibility on a set-shifting task. This particular task had participants switch their task set in a predictable AABB pattern. Thus, the task had an equal number of switch and non-switch trials and most closely resembles the even context in the present studies. Context may have moderated the relationship between motivation and attentional flexibility in their study. Based on our results, we would predict that if there had been a smaller proportion of switch trials in their study, switch costs might have been lower in the approach condition.

Likewise, context effects may have influenced the findings of Friedman and Förster (2005), who used a two-back task to operationalize flexibility. In this task, participants view a series of letters and must indicate when the current letter is the same as the letter viewed two items ago. Although this task is not as clearly analogous to the Navon letter task as a set-shifting paradigm, it does involve flexibly allocating attentional resources to a changing series of letters. Importantly, in this study, only 10 of 45 trials required a "yes" response, thus the need to respond was fairly rare. It is possible that this trial ratio created a context similar to the uneven blocks in the present study, and may help explain why, in that study, approach motivational cues enhanced performance.

One important limitation of the present studies is their inability to directly examine changes in non-switch trial RTs. This is because the uneven blocks contained very few trials in some design cells (e.g., non-switch local trials on mostly global blocks), which led to insufficient power to examine this question. We attempted to mitigate this issue by first pooling all switch and all non-switch trials to determine which trial types were driving the effects, and then by examining switch RTs (separately from non-switch RTs) to separate switching to global and switching to local targets. This alternative analysis strategy allowed for exploration of the asymmetrical pattern in the data; however, some questions remain unanswered. In particular, the opportunity to examine non-switch RTs would have been useful for Study 4, in which the interaction between motivation and context was present for both switch and non-switch trials. Future studies that can directly examine reaction times of each trial type will be important to further understanding of context effects.

Another limitation of this study is that we are unable to rule out the possibility that some other factor, rather than motivation, caused the differences observed between motivation conditions. Because of the within-subjects design and the quick shifts between different motivation conditions, we chose not to include an explicit manipulation check. The approach manipulations used may have led to more off-task thinking compared to the avoidance manipulations, which could reduce attentional resources devoted to the task context. For instance, the appetitive images may have led to a greater number of off-task thoughts, compared to the aversive images, because they depicted things that people might have been intrinsically motivated to think about (e.g., food). Additionally, in spite of careful instructions to exert the same amount of effort for both the approach and the avoidance arm positions, the approach condition may still have required greater effort, which may have increased the likelihood of task-unrelated thinking. Thus, although the use of multiple motivation manipulations did rule out some potentially confounding variables, we are not able to eliminate the possibility that task-irrelevant thoughts in the approach conditions may have contributed to their reduced sensitivity to the context. Subsequent studies would benefit from an explicit measure of task unrelated thinking, as well as a manipulation check in order to control for this alternative possibility.

In the future, it will also be important to determine whether these context effects can be replicated using different tasks. The Navon composite figures task has proved to be invaluable for studying attentional breadth, but has yielded discrepant results in past research. In contrast to the work of Gable and Harmon-Jones (e.g., 2010b), participants in a different study performed the task after virtual enactment of approach and avoidance behaviors, and found that approach motivation led to a more global attentional bias, whereas avoidance motivation led to a more local bias (Förster, Friedman, Özelsel, & Denzler, 2006). The fact that this task has shown inconsistent results in the past under similar conditions underscores the importance of subtle factors (e.g., block-level context) in determining participants' degree of global or local attentional bias. One strength of the present studies is that they identified context as one factor that could contribute to these divergent results. However, further research is needed to identify other sources of inconsistency across experiments using the Navon composite letter task.

The present findings contribute to understanding motivation–attention interactions. Attentional shifts are pervasive in our everyday lives and are important for adaptively responding to a changing environment. How people attend to environmental stimuli can depend, in large part, on their current motivational state. These studies are important because they underscore the importance of considering the context when studying motivation-related attentional shifts, both in a broader sense (in terms of the whole block) and a narrower sense (in terms of the previous trial). When this kind of context is taken into consideration, we find that avoidance motivation may be beneficial in a predictable environment, but approach motivation may facilitate responding to unexpected or rare environmental stimuli.

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