Rejecting salient distractors: Generalization from experience

Daniel B. Vatterott\textsuperscript{a}
Michael C. Mozer\textsuperscript{b}
Shaun P. Vecera\textsuperscript{a}

\textsuperscript{a} Department of Psychological & Brain Sciences
University of Iowa, W311 Seashore Hall
Iowa City, IA 52242-1407

\textsuperscript{b} Department of Computer Science, University of Colorado, Boulder, CO 80309-0430

Corresponding Author:
Shaun P. Vecera
Department of Psychological and Brain Sciences
University of Iowa, W311 Seashore Hall
Iowa City, IA 52242-1407

Electronic mail:
shaun-vecera@uiowa.edu
Abstract

Distraction impairs performance in many important everyday tasks such as driving. Attentional control limits distraction by preferentially selecting important items for limited capacity cognitive operations. Research in attentional control has typically investigated the degree to which selection of items is stimulus driven versus goal driven. Recent work finds that when observers initially learn a task, selection is based on stimulus-driven factors, but through experience, goal-driven factors have an increasing influence. The modulation of selection by goals has been studied within the paradigm of learned distractor rejection, in which experience over a sequence of trials enables individuals to eventually ignore a perceptually salient distractor. The experiments presented here examine whether observers can generalize learned distractor rejection to novel distractors. Observers searched for a target and ignored a salient color-singleton distractor that appeared in half the trials. In Experiment 1, observers who learned distractor rejection in a variable environment rejected a novel distractor more effectively than observers who learned distractor rejection in a less variable, homogeneous environment, demonstrating that variable, heterogeneous stimulus environments encourage generalizable learned distractor rejection. Experiments 2 and 3 investigated the time course of learned distractor rejection across the experiment and found that after experiencing four color-singleton distractors in different blocks, observers could effectively reject subsequent novel color-singleton distractors. These results suggest that the optimization of attentional control to the task environment can be interpreted as a form of learning, demonstrating experience’s critical role in attentional control.
Although we effortlessly produce appropriate actions when doing simple actions such as making a cup of coffee, there are multiple limited capacity cognitive operations between sensing an item (e.g., the coffee grinder) and producing an appropriate action (e.g., placing coffee beans in the grinder). Effective behavior requires that these limited capacity operations selectively process relevant items. Attention is the selection of items for these limited capacity operations, and an important question in attentional research is how limited capacity mechanisms choose what items to select (i.e., attentional control). Obviously, individuals want to select important items, but what makes an item important? Attentional control research has investigated whether individuals determine an item’s importance via visual salience (stimulus-driven inputs) or observers’ goals (goal-driven inputs; see Vecera, Cosman, Vatterott, & Roper, 2014; also see Awh, Theeuwes, & Belopolsky, 2012). Researchers supporting the stimulus-driven account claim that individuals initially select the most salient items in the environment (e.g., Theeuwes, 2010; Itti & Koch, 2000). Researchers supporting the goal-driven account claim that individuals initially select items fitting observers’ current goals (e.g., Folk et al., 1992).

Evidence for the stimulus-driven account primarily derives from the additional-singleton paradigm (Theeuwes, 1992), in which observers search for a shape-singleton target among homogeneously shaped distractors. In half the trials, the distractors are the same color as the target, but in the other half, one distractor is a different color (i.e., color-singleton distractor). The target is never this oddly colored item, making the color-singleton task irrelevant. Nonetheless, observers respond slower when the color-singleton distractor is present than absent, indicating that the color singleton distracted observers (Theeuwes, 2010). However, a salient but
irrelevant color singleton does not always slow responses (Bacon & Egeth, 1994), suggesting a role for goal-driven factors, such as the search ‘mode’ a participant might employ.

Although researchers typically portray attentional control as an immutable system using either stimulus-driven or goal-driven inputs, recent accounts have emphasized the interplay of stimulus-driven and goal-relevant factors (e.g., Gaspelin, Leonard, & Luck, 2015, 2017). One factor that appears to integrate stimulus- and goal-driven factors is the role experience plays in the balancing between these inputs (for reviews see Awh et al., 2012; Vecera et al., 2014). For example, individuals select targets sooner if the targets appear in a consistent, predictable relationship with distractors, an effect termed contextual cuing (Chun, 2000; Chun & Jiang, 1998). More immediate experience also affects attention: targets are discriminated quicker when preceded by a similar target than a dissimilar target, as in priming of popout (e.g., Maljkovic & Nakayama, 1994, 1996, 2000; for review see Kristjánsson & Campana, 2010). The foregoing examples center on how experience influences target localization and discrimination; however, effective attentional selection also requires one to reject distracting information and objects.

Experience appears to affect distractor rejection. For instance, Leber and Egeth (2006) trained observers with displays that either encouraged observers to search specifically for the target (i.e., feature-search mode; Bacon & Egeth, 1994) or generally for unique items (i.e., singleton-detection mode; Pashler 1988). All observers then completed a test phase with displays, termed ‘option trials,’ in which search could be deployed in either feature-search mode or singleton-search mode. Leber and Egeth (2006) found that color singletons during the option trials did not distract observers if the observers previously trained with displays that encouraged them to search for a specific target. Color singletons during the option trials did distract observers if the observers previously trained with displays that encouraged them to search for
Experience and distractor rejection

unique items. Thus, past experience using an imprecise search strategy made observers susceptible to distraction.

Vatterott and Vecera (2012) investigated the role of distractor-rejection experience on attentional control. Observers began with a training block that encouraged a precise search strategy, searching for a target shape (e.g., circle) among heterogeneously shaped distractors (triangles, diamonds, and squares). During this training phase, color-singleton distractors never appeared. Following the training phase, blocks of trials were presented in which a color-singleton distractor appeared in 50% of the trials. Importantly, the color of the singleton distractor changed each block. Varying the distractor color allowed Vatterott and Vecera (2012) to distinguish among three alternative mechanisms of attentional control. If search strategy alone was sufficient to effectively reject color-singleton distractors, then the color-singletons should never distract individuals. Alternatively, observers might need general experience rejecting any salient distractor. In this case, color-singletons in the early part of the first block distract observers because they are novel, but observers learn to effectively reject them (say, in the second half of the first test block) and then effectively reject all following color-singleton distractors. Finally, observers might require experience rejecting each distinct color-singleton to effectively reject other singletons of the same color. In this scenario, each time the color of the singleton changes, the color-singleton distract observers in the early part of each block before observers have sufficient experience to effectively reject it. Vatterott and Vecera (2012) found support for the final hypothesis: Even when observers use feature-search mode, they must experience each color-singleton to effectively learn to reject them. These results suggest that observers learn to reject distractors through item-specific experience. We refer to this item-specific learning as learned distractor rejection.
Recent research demonstrates that attentional control constantly adjusts to the environment (Cosman & Vecera, 2014; Leber & Egeth, 2006; Vatterott & Vecera, 2012), but little is known about how attentional learning compares to other types of learning. Past work in our lab demonstrates that at least one type of attentional learning, learned distractor rejection, is item specific (Vatterott & Vecera, 2012). Other forms of learning, such as skill learning, also often exhibits highly specific learning, but this learning generalizes under the right circumstances, for example, when practice is variable (for review, see Schmidt & Bjork, 1992). The experiments in this article examine whether observers can generalize learned distractor rejection. We will first investigate whether variable practice encourages generalization of learned distractor rejection. Previously, we found evidence that learned distractor rejection was item specific when the salient distractors appeared in a blocked manner (Vatterott & Vecera, 2012). Here we ask if a more variable, heterogeneous distractor environment could produce a distractor rejection strategy that generalized to novel items.

Previous research in a variety of domains has demonstrated that variable environments help individuals generalize learning more effectively to novel environments (for a review, see Schmidt & Bjork, 1992). For example, in a perceptual coincident timing task, Catalano and Kleiner (1984) sat observers sat in front of a column of lights illuminated in succession create the perception of an object moving toward the observer at a constant rate. Observers responded when the light closest to the observer lit. In test trials, observers who were trained with variable approach speeds generalized better to novel approach speeds than observers trained with constant speeds. When learning to discriminate the English phonemes /l/ and /r/, native Japanese participants were better able to generalize to new English speakers when those participants had heard the phonemes produced by varied speakers, suggesting that variability in phoneme
production across speakers allowed phoneme discrimination to generalize more effectively to a new talker (Lively, et al., 1993). Similarly, category formation is influenced by the variability of category members. When category members were highly variable during category learning, participants’ transfer to new stimuli was better than if category members were less variable (Homa & Vosburgh, 1976).

The current experiments test whether a heterogeneous environment is better suited than a homogeneous environment for training observers to reject novel distractors. If learned distractor rejection uses learning mechanisms similar to other types of learning, a variable, heterogeneous distractor environment might enable observers to reject novel distractors without previously experiencing these specific distractors.

The following experiments are largely modeled after Vatterott and Vecera (2012), with some key exceptions. In Experiment 1, half of the observers experienced a heterogeneous stimulus environment in which three different color-singletons appeared interspersed throughout three blocks (Mixed group). The other half of observers experienced a homogeneous stimulus environment in which a different singleton color appeared in each of three blocks (Blocked group), replicating Vatterott and Vecera (2012). Both groups were then tested with a novel distractor color in a final block of trials; this final block always contained a single distractor color, which appeared on half of the trials. If learned distractor rejection is better generalized following variable training than fixed training, then a novel color-singleton in the fourth block will initially distract observers in the Blocked group, but it may not distract observers in the Mixed group. If learned distractor rejection is completely item specific and shows no tendency to generalize, then the novel color-singleton will initially distract observers in both groups.
Experiment 1

Methods

Participants. Thirty-seven University of Iowa undergraduates completed the experiment for partial course credit. All reported normal or corrected to normal vision.

Apparatus. A Macintosh Mini computer using MATLAB and the Psychophysics Toolbox (Brainard, 1997) collected responses and presented the stimuli on a 17-in. CRT display. Observers sat approximately 60 cm from the display.

Stimuli and Procedure. Six colored shapes equally spaced around the circumference of an imaginary circle centered at fixation with a radius of 4.2° composed the displays. Fixation was a small white circle in the center of the screen. Each shape was roughly 2.5° square and contained a randomly vertically or horizontally oriented line (0.7° x 1°). The stimuli consisted of a target (circle) and five distractors (triangle, diamond, or square). The target position was chosen pseudo-randomly on each trial. The identity of each distractor was chosen pseudo-randomly on each trial, with the only constraint being that the distractors were not all the same identity. The target and all distractors were green (RGB 0, 255, 0) except on singleton present trials when one distractor was either red (RGB 255, 0, 0), yellow (RGB 255, 255, 0), purple (RGB 255, 0, 255), or orange (RGB 255, 150, 0). The color-singleton position was chosen randomly from among the distractors on each trial.

Each trial began with only the fixation point visible for 1,000 ms followed by the search display for 5,000 ms or until response. If an observer failed to respond within 5,000 ms, the observer was encouraged to respond faster and the trial was marked as incorrect. A beep informed observers of incorrect responses.
Observers pressed either the “z” or “m” key to indicate the orientation of the line within the target green circle. Key binding was counter-balanced across observers. The orientation of the line within the circle was chosen pseudo-randomly on each trial. Observers were instructed to respond as quickly and accurately as possible and that a differently colored item might appear on some of the trials, but this item would never be the target, so they should do their best to ignore it. Eye movements were not monitored, but observers were encouraged to maintain fixation.

All observers started the experiment with a 60-trial training block in which observers searched for the target circle among heterogeneously shaped green distractors. Following the training block, all observers completed four test blocks of 48 trials each. One of the distractors was differently colored (i.e., a color-singleton) in 50% of the trials. The color of the color-singleton remained the same throughout an entire test block, but changed between blocks in the Blocked group. See the right panel of Figure 1 for a depiction of this procedure. The same three colored color-singletons appeared intermixed in the first three blocks in the Mixed group. See the left panel of Figure 1 for a depiction of this procedure. A single novel color-singleton appeared in 50% of the trials of the fourth test block. The order of the color-singleton colors was counter-balanced across observers. A short self-paced rest break preceded each block.

Results

RTs more than five standard deviations above and two standard deviations below an observer’s mean of each condition were removed from the analysis. This trimming eliminated less than 0.005% of the data. Incorrect RTs, and RTs following an incorrect response also were removed from the analysis. Three observers from the Blocked group and two from the Mixed group were excluded due to accuracy 2.5 standard deviations below the average accuracy of all observers.
For the Blocked group, we compared RTs in the first and second halves of Blocks 1-3 for trials in which color-singletons were present or absent (upper panel of Figure 2). We split RTs into the first and second halves of blocks because this convenient analysis adequately measured learned distractor rejection in past work (Vatterott & Vecera, 2012). To measure whether singleton distractors distracted observers in the Blocked group early in blocks than late, we entered the RT data from Blocks 1-3 into a 2x2 repeated measures ANOVA with trial position (RTs from the first or second half of a block) and singleton presence (singleton present or absent) as the factors. There was no effect of trial position, $F < 1$, but we did find a main effect of singleton presence, $F(1, 15) = 7.75, p < 0.05, \eta_p^2 = 0.34$. Longer RTs when the singleton was present (914 ms) than absent (877 ms) drove this main effect. The analyses also revealed a marginally significant interaction between trial position and singleton presence, $F(1, 15) = 3.85, p = 0.068, \eta_p^2 = 0.20$. Planned comparisons confirmed that observers responded slower when the color-singleton was present (937 ms) than absent (867 ms) in the first half of blocks, $t(15) = 2.84, p < 0.05, \eta_p^2 = 0.35$, but not the second half, $t < 1$ (Singleton Present: 888 ms; Singleton Absent: 883 ms). Thus, during the first half of blocks color-singletons distracted observers in the Blocked group, replicating Vatterott and Vecera (2012). Color-singletons distracted observers when novel in the first half of blocks but not in the second half when the color-singletons were more familiar.

Because the Mixed group experienced multiple color-singletons distractors within each block, the block-half analysis we performed for the Blocked group are not suitable (the distractor statistics did not change across blocks). Instead of a block-half analysis, the lower panel of Figure 2 shows the Mixed group’s RTs as a function of block. To measure changes in distraction across the three blocks, we entered RTs into a 3x2 repeated measures ANOVA with the factors
Experience and distractor rejection

block number (Blocks 1, 2, and 3) and singleton presence (singleton present versus absent) as the factors. There was neither a main effect of block number, $F(2, 30) = 2.03, p > 0.14, \eta_p^2 = 0.12$, nor a main effect of singleton presence, $F < 1$. The analyses did, however, reveal a significant interaction between block number and singleton presence, $F(2, 30) = 7.41, p < 0.01, \eta_p^2 = 0.33$. Planned comparisons found observers responded slower when the color-singleton was present (841 ms) than absent (786 ms) in the first block, $t(15) = 4.66, p < 0.01, \eta_p^2 = 0.59$, but not in the second block, $t < 1$ (Singleton Present: 779 ms; Singleton Absent: 776 ms), or the third, $t(15) = 1.71, p > 0.1, \eta_p^2 = 0.16$ (Singleton Present: 794 ms; Singleton Absent: 838 ms). These tests indicate that color-singletons distracted observers in the first block when the color-singletons were novel, but observers learned to reject the color-singletons and they did not distract observers in the second or third block when the color-singletons were more familiar.

Moving onto the critical comparison, we investigated performance in the fourth block of the experiment, which was identical for both groups. In particular, we were interested in whether the stimulus environment changes observers’ ability to reject novel color-singletons. Inspection of these results, depicted in Figure 3, indicate that observers in the Blocked group were initially slowed by the new distractor color in Block 4, but these observers quickly tuned their distractor rejection to avoid being slowed by the color singleton. In contrast, observers in the Mixed condition showed no initial slowing by the new distractor color in Block 4, suggesting these observers had generalized their distractor rejection.

These observations were corroborated by our statistical analyses. Block 4 RTs were entered into a 2x2x2 mixed measures ANOVA with the factors trial position (first block half versus second), singleton presence (present versus absent) and stimulus environment (Blocked versus Mixed group). Block 4 RTs from both groups appear in Figure 3. There was neither a
Experience and distractor rejection

main effect of trial position, $F < 1$, nor singleton presence, $F < 1$. There was no main effect of group, $F(1,30) = 1.86, p > 0.18, \eta_p^2 = 0.26$. The ANOVA also found neither an interaction between trial position and group, $F(1,30) = 2.58, p > 0.1, \eta_p^2 = 0.08$, nor an interaction between trial position and singleton presence, $F(1, 30) = 1.43, p > 0.24, \eta_p^2 = 0.05$. The ANOVA found a marginally significant interaction between singleton presence and group, $F(1,30) = 3.92, p = 0.057, \eta_p^2 = 0.12$. Importantly, the results revealed a significant three-way interaction between trial position, singleton presence, and group, $F(1, 30) = 5.14, p < 0.05, \eta_p^2 = 0.15$. This interaction demonstrates that color-singletons had a different effect on RTs depending on block half and group. Planned comparisons found that observers in the Blocked group responded slower when the color-singleton was present (962 ms) in the first half of Block 4 than when it was absent (850 ms), $t(15) = 2.59, p < 0.05, \eta_p^2 = 0.31$. Observers in the Blocked group did not respond slower when the color-singleton was present (858 ms; Singleton Absent: 868 ms) in the second half of the block, $t < 1$. Observers in the Mixed group did not respond slower when the color-singleton was present (773 ms; Singleton Absent: 814 ms) in the first half of Block 4, $t(15) = 1.62, p > 0.1, \eta_p^2 = 0.15$. Color-singletons also did not slow Mixed group responses during the second half of the block, $t < 1$ (Singleton Present: 804 ms; Singleton Absent: 808 ms).

Importantly, color-singletons slowed the Blocked group’s responses more in the first half of Block 4 than the Mixed group’s responses, $t(30) = 3.05, p < 0.01, \eta_p^2 = 0.24$. This was not true during the second half of Block 4, $t < 1$. These tests indicate that color-singletons initially distracted observers in the Blocked group, but not the Mixed group. Thus, a heterogeneous stimulus environment, gave observers the ability to ignore a salient color-singleton distractor without previously experiencing this item.
Error rates from each condition appear in the base of the bars depicting RTs from that condition (see Figures 2-3). We transformed accuracy values via an arcsine square-root transformation (Freeman & Tukey, 1950), and submitted these values to the same ANOVAs as the RTs. First, we submitted the transformed accuracy values from Blocks 1-3 of the Blocked group to a 2x2 repeated measures ANOVA with the factors trial position and singleton presence. The ANOVA found neither significant main effects nor interactions, all Fs < 1. Next, we submitted the transformed accuracy values from Blocks 1-3 of the Mixed group to a 3x2 repeated measures ANOVA with the factors block and singleton presence. The ANOVA found neither a main effect of block, $F < 1$, nor a main effect of singleton presence, $F(1, 15) = 2.14, p > 0.16, \eta_p^2 = 0.12$. The ANOVA also failed to find an interaction between block and singleton presence, $F(2, 30) = 1.57, p > 0.22, \eta_p^2 = 0.09$. Finally, we submitted the Block 4 transformed accuracy values to a 2x2x2 mixed measures ANOVA with the factors trial position, singleton presence, and group. The ANOVA found no main effect of trial position, $F(1, 30) = 2.60, p > 0.11, \eta_p^2 = 0.08$, nor a main effect of singleton presence, $F < 1$. The ANOVA did find a significant interaction between singleton presence, trial position, and group, $F(1, 30) = 9.45, p < 0.005, \eta_p^2 = 0.24$. Follow-up comparisons indicate that higher accuracy in singleton present than singleton absent trials of the blocked group during the first half of the block drove this interaction, $t(15) = 2.61, p < 0.05, \eta_p^2 = 0.31$. It is likely that the response-terminated displays kept observers’ accuracy at ceiling, which hindered our ability to find significant accuracy differences across the conditions.

Discussion

In Experiment 1, experience with heterogeneous salient distractors enables observers to ignore novel salient distractors (the Mixed environment), whereas experience with homogeneous
Experience and distractor rejection

salient distractors does not (the Blocked environment). Thus, learned distractor rejection obeys at least one principle observed in skill learning: Heterogeneous practice encourages generalization of learning (Schmidt & Bjork, 1992).

The generalization observed in this experiment reflects better discrimination of targets from distractors. Discrimination requires constructing a template of both targets and distractors. In Experiment 1, experience might have encouraged a more precise target template (Bacon & Egeth, 1994). For instance, observers might have learned to reject distractors not by learning to ignore a specific color value, but by narrowing their target template (Becker, Folk, & Remington, 2010). In our experiment, observers might begin by searching for a circle of any color and narrow their target template when experiencing salient color singleton distractors. The increased variability in the heterogeneous stimulus environment might encourage more drastic narrowing of this target template. Observers might learn to reject distractors, irrespective of the precision of the target template. The heterogeneous stimulus environment might encourage observers to create more generalizable distractor rejection templates (Arita, Carlisle, & Woodman, 2012; also see Beck & Hollingworth, 2015). For instance, observers might learn to reject specific distractor colors, but the heterogeneous stimulus environment causes observers to create less specific distractor rejection templates. These less precise distractor rejection templates make novel distractors more likely to fall within the color range specified by the rejection templates, and leave observers immune to distraction by novel distractors.

These results indicate that we do not simply instantiate an attentional control state by selecting a search mode (Bacon & Egeth, 1994) or by choosing a target template (Desimone & Duncan, 1995). Instead, attentional control is gradually honed across experience (Logan, 2002; Chun & Jiang, 2003; Cosman & Vecera, 2014). The attentional control system should not be
thought of as a monolithic cognitive system ruled by either stimulus-driven or goal-driven inputs. Instead, the attentional control system constantly adapts to the task, changing the priorities of stimulus and goal-driven inputs (Vecera et al., 2014). In retrospect, it seems necessary that any adaptation to a stimulus environment cannot be instantaneous, because experience over a sequence of trials is required to learn statistics of the stimulus environment which form the basis for target and distractor templates (Mozer & Baldwin, 2008).

In Experiment 1, the overall distractor statistics observed by Blocked and Mixed groups were identical: for both groups, over the first three blocks, the distractor color was chosen from three alternatives with equal probability. The statistics differ only in the sequence of colors. One explanation for why generalization is better with heterogeneity is that learning is recency based (Mozer & Baldwin, 2008), and performance in the final block of the experiment depends primarily on the statistics of the distractors in the penultimate block. If recency drives learning, one might expect it to be impossible for observers to learn a generalizable distractor rejection strategy in a blocked distractor environment.

Conflicting with this account, past work from our lab (Vecera et al., 2014) found that when observers learn to ignore a particular salient distractor, they maintain this learned distractor rejection template across the experiment, even with intervening distractors. If observers retain a learned distractor rejection template over the course of the experiment and these templates have any imprecision such that a green distractor rejection template leads to the rejection of all greenish distractors, then as observers gain experience with different distractors they will be more likely to immediately reject novel distractors.

Experiment 2 was designed to resolve the apparent conflict between the result of Experiment 1, which suggests that learning is short lived, and results of Vecera et al. (2014),
Experience and distractor rejection

which suggests that learning persists for longer, possibly for the duration of the entire experiment. Perhaps generalization may occur in principle with homogeneous environments, but there simply was not a sufficient number of homogeneous environments in Experiment 1 or a sufficient number of trials to observe generalization. To test this hypothesis, in Experiment 2, we presented a sequence of six, not four, homogeneous environments, and we extended the length of each block from 48 to 144 trials. Observers searched for a circle among heterogeneously shaped distractors over six blocks. A color-singleton appeared in half the trials, and the color of the color-singleton distractor was blocked.

If learned distractor rejection is purely recency based, then increasing the number of trials and blocks of different color-singletons would not alter observers’ distractor rejection. Specifically, observers would remain distracted by the appearance of a novel color singleton distractor because that distractor had not been experienced previously. However, if distractor rejection is affected by longer-term learning, then the increased number of trials and/or blocks might allow for effective distractor rejection after a sufficient number of color singleton distractors had been experienced. In short, generalization might occur based on some number of distractors had been encountered, even though those distractors were presented in a blocked fashion. Under this view, observers would not be distracted by the appearance of a novel color singleton in later blocks of the experiment.

**Experiment 2**

In Experiment 2 we investigated whether learned distractor rejection is purely recency based or if learned distractor rejection persists across longer time scales. To distinguish between these hypotheses, we used the Blocked group design from Experiment 1, expanded the color-singleton distractor set from four colors to six and extended the length of each block from 48 to
144 trials. Observers began the experiment with a 60 trial training-block as in Experiment 1, and by the end of the fourth block of trials, observers performed 636 trials searching for a constant target shape. By performing many trials, our hope was to provide observers with sufficient experience to form well specified target and distractor templates, producing a strong test of distractor rejection templates’ ability to persist across the experiment. If learned distractor rejection is purely recency based, then each time the salient color-singleton changes color, the new distractor should slow observers’ RTs, irrespective of the number of color-singletons previously experienced. If learned distractor rejection is robust and persistent, then color singletons will become less distracting as observers progress through the experiment, even after changes in the singleton's color.

Methods

Participants. Twenty-two observers completed the experiment for partial course credit. All reported normal or corrected to normal vision.

Apparatus. Experiment 2 used the same apparatus as Experiment 1.

Stimuli and Procedure. Experiment 2 used the same methods as in Experiment 1 except for the following changes. Observers completed six blocks of trials instead of four, which means the observers experienced two additional color-singleton distractors (six total) and the test blocks were lengthened to from 48 to 144 trials. The two additional color-singleton colors were blue (RGB 0, 0, 255) and teal (RGB 0, 255, 255).

Results

We used the same data trimming techniques as in Experiment 1. This trimming eliminated less than 0.005% of the data. Four observers were excluded due to accuracy 2.5 standard deviations below the mean accuracy of all observers.
In Experiment 1, we found observers needed experience with salient distractors before they can effectively ignore these items (also see Vatterott & Vecera, 2012). Observers in the Blocked group of Experiment 1 experienced four distinct color-singleton distractors, each in a different block. In the current experiment, we investigated whether experience with a greater number of color-singleton distractors might enable observers to immediately ignore novel color-singleton distractors. For this reason, we compare observers’ ability to immediately reject the first four color-singleton distractors (Blocks 1-4, when we previously found color-singleton distractors elicit distraction) to observers’ ability to reject color-singleton distractors after the first four (Blocks 5-6). In our previous demonstration of learned distractor rejection (Vatterott & Vecera, 2012), we divided blocks in an *early* period (first 12 experience with the color-singleton and first twelve trials without the color-singleton) and a *late* period (last 12 experience with the color-singleton and last twelve trials without the color-singleton). In the current experiment, we followed this convention and divided blocks into early trials (first 12 experience with the color-singleton and first twelve trials without the color-singleton) and late trials (trials after the first 12 experiences with and without the color singleton). We used this binning in order to best replicate the early trials of our previous work.

The upper panel of Figure 4 depicts observers’ RTs across the first four blocks. The lower panel of Figure 4 depicts observers’ RTs across the last two blocks. To evaluate whether observers’ ability to reject novel distractors changed after experiencing four novel distractors, we submitted RTs to a 2x2x2 repeated measures ANOVA with the factors color singleton presence (present versus absent), trial order (Early Trials versus the Late Trials), and experiment order (Blocks 1-4 versus Blocks 5-6). The analyses revealed a marginally significant effect of singleton presence, $F(1, 17) = 3.56, p = 0.08$, $\eta^2_p = 0.17$, driven by slower RTs when the color
Experience and distractor rejection

singleton was present (728 ms) than absent (712 ms). There was a significant effect of trial order, $F(1,17) = 7.67, p < 0.05, \eta_p^2 = 0.31$, driven by slower RTs in the first 24 trials of a block (732 ms) than the later trials (708 ms). Experiment order produced a significant effect, $F(1, 17) = 8.54, p < 0.001, \eta_p^2 = 0.33$, with slower RTs in the first four blocks (747 ms) than the last two (693 ms). We found a significant interaction between singleton presence and experiment order, $F(1, 17) = 24.29, p < 0.001, \eta_p^2 = 0.59$. Finally, and most important, all of these effects were subsumed by a three-way interaction between singleton presence, trial order, and experiment order interaction, $F(1,17) = 34.84, p < 0.001, \eta_p^2 = 0.67$.

We conducted a series of planned comparisons to fully understand this three-way interaction. We found color singletons distracted observers in the Early Trials of Blocks 1-4, where observers responded slower when color singletons was present (799 ms) than absent (729 ms), $t(17) = 5.18, p < 0.001, \eta_p^2 = 0.61$. Color singletons did not distract observers in the Late Trials of Blocks 1-4, where observers responded equally fast when the color singleton was present (732 ms) and absent (725 ms), $t(17) = 1.21, p > 0.2, \eta_p^2 = 0.08$. These findings generally parallel those from the Blocked group in Experiment 1 and those reported in Vatterott and Vecera (2012).

In contrast with the results from Blocks 1-4, Color singletons did not distract observers in Blocks 5 and 6, where observers responded equally fast when the color singleton was present (691 ms) and absent (709 ms) during the first 24 trials $t(17) = 1.04, p > 0.3, \eta_p^2 = 0.06$, and after the first 24 trials, $t < 1$ (687 ms; Singleton Absent: 684 ms). In Blocks 1-4, the results replicate the blocked condition of Experiment 1. In Blocks 5-6, however, observers were able to reject the salient color singletons without previously experiencing them.
Error rates from each condition appear in the base of bars depicting RTs from that condition (see Figure 4). We transformed accuracy values via an arcsine square-root transformation as in Experiment 1 and submitted the transformed accuracies to the same 2x2x2 repeated measures ANOVA as the RTs. This ANOVA found neither a main effect of singleton presence, $F < 1$, nor a main effect of experiment order, $F(1, 17) = 1.67, p > 0.21, \eta_p^2 = 0.09$. The ANOVA did find a main effect of trial order, $F(1, 17) = 21.25, p < 0.001, \eta_p^2 = 0.56$, reflecting higher accuracy early in a block than later. We suspect observers grew fatigued as they progressed through blocks and this lowered accuracy. None of the interactions were significant, all $ps > 0.26$.

**Discussion**

In Experiment 2 we found that when a novel color singleton was introduced at the beginning of Blocks 1-4, observers failed to effectively reject the color-singleton. However, after about 12 experiences with the color singleton, observers were able to effectively reject the color singletons and color singletons ceased to distract observers, replicating our previous results (Vatterott & Vecera, 2012) and the Blocked group of Experiment 1. In the initial trials of Blocks 5 and 6, a novel color singleton did not distract observers, in contrast to the initial trials of Blocks 1-4. This finding suggests that learned distractor rejection is not entirely recency based because even in a homogeneous stimulus environment, observers can learn to effectively reject salient color-singletons without previously experiencing these items. Thus, observers do retain some type of memory trace for distractor rejection that persists over the time course of the experiment, indicating that learned distractor rejection operates over multiple time scales: the short time scale of learning to suppress a novel color singleton early in Blocks 1-4, and the long time scale of learning to suppress a novel color singleton at the start of Blocks 5 and 6.
Comparing Experiment 2 to the blocked conditions of Experiment 1, we cannot determine whether long time-scale learning arises from the greater number of distractor colors rejected in Experiment 2 or from the greater overall number of trials performed. That is, either performing more trials generally or experiencing more color-singleton distractor identities might have led to inter-block learning, which was expressed through the ability to immediately reject novel color singleton distractors in Blocks 5 and 6. In Experiment 3 we sought to decouple these two factors by maintaining block length, but limiting the number of different color-singletons.

**Experiment 3**

The trial sequence in Experiment 3 matched that in Experiment 2, except that the color singleton’s color remained constant in Blocks 1-4. Observers subsequently experienced novel color singletons in Blocks 5 and 6. If performing more trials in Experiment 2 relative to Experiment 1 enabled observers to immediately reject salient color-singletons, then observers should immediately reject color singletons in Blocks 5 and 6. If experiencing more color singletons enabled observers to immediately reject salient color-singletons, then color-singletons should initially distract observers in Blocks 5 and 6 because observers will only have experienced one color-singleton going into Block 5 and two color-singletons going into Block 6.

**Methods**

*Participants.* Twenty observers completed the experiment for partial course credit. All observers reported normal or corrected to normal vision.

*Apparatus.* Experiment 3 used the same apparatus as Experiments 1 and 2.

*Stimuli and Procedure.* Experiment 3 used the same methods as Experiment 2 except that the color-singleton did not change color throughout Blocks 1-4. Then, observers experienced
new color-singletons in Blocks 5 and 6. Thus, in total, observers experienced new color-singletons in Blocks 1, 5, and 6. This design change resulted in only three different color-singleton colors. Experiment 3 used red, orange, and purple as the color-singleton colors.

**Results**

We used the same data trimming techniques as Experiments 1 and 2. This trimming eliminated less than 0.005% of the data. We excluded two observers for mean accuracy 2.5 standard deviations below the grand average accuracy.

Experiment 3 results appear in Figure 6. Blocks 1, 5, and 6 all have novel color-singletons. Blocks 2-4 have familiar color-singletons. To determine whether observers’ ability to immediately reject novel color singletons (in Experiment 2) arises from the number of trials performed or the number of color singleton identities experienced, we performed a 2x2x2 repeated measures ANOVA with the factors singleton presence (singleton present versus singleton absent), trial order (Early Trials versus Late Trials), and color singleton familiarity within a block (Blocks 1, 5, & 6 versus Blocks 2-4). The analyses revealed a marginally significant effect of singleton presence, with slightly longer RTs on singleton present (728 ms) than singleton absent trials (716 ms), $F(1, 17) = 3.85, p = 0.07, \eta_p^2 = 0.18$. There also was a marginally significant interaction between singleton presence and singleton familiarity, $F(1, 17) = 4.23, p = 0.06, \eta_p^2 = 0.20$. Interestingly, the interaction between singleton presence, trial order, and singleton familiarity was not significant, $F(1, 17) = 2.47, p > 0.13$. Planned follow-up comparisons found observers responded marginally slower during the Early Trials of Blocks 1, 5, & 6 when the color singleton was present (747 ms) than absent (708 ms), $t(17) = 2.01, p = 0.06, \eta_p^2 = 0.19$. Observers RTs did not differ in the Late Trials of the Blocks 1, 5, & 6, $t < 1$ (Singleton Present: 714 ms; Singleton Absent: 711 ms). Observers’ RTs did not differ in the Early Trials of
Experience and distractor rejection

Blocks 2-4, $t < 1$ (Singleton Present: 708 ms; Singleton Absent: 713 ms). RTs also did not differ in the Late Trials of Blocks 2-4, $t < 1$ (Singleton Present: 723 ms; Singleton Absent: 720 ms).

We hypothesized that we did not observe a significant interaction between color-singleton familiarity, color-singleton presence, and trial order because observers may become immune to distraction in the later blocks, specifically in Block 6, possibly due to some effect of overall task experience. To test this hypothesis, we investigated whether novel color-singletons distracted observers in Block 5, the first block in which a new distractor color appeared.

Critically, observers responded more slowly when the color-singleton was present (774 ms) than absent (705 ms) in the Early Trials of Block 5, $t(17) = 2.12, p < 0.05, \eta^2_p = 0.21$ (see top panel, Figure 6). This means that even after performing a training block and four test blocks (636 trials) a novel salient color singleton still distracted observers. RTs were no different in the Early trials when the color singleton was present (722 ms) and absent (706 ms) in Block 6, $t < 1$ (see bottom panel, Figure 6), demonstrating that novel color singletons did not distract observers in Block 6.

Color singletons initially distracted observers in Block 5 suggesting that experiencing more than four color-singletons reduces the ability of future color-singletons to distract observers. Color singletons did not distract observers in Block 6 suggesting that overall task experience also reduces the ability of color-singletons to distract observers.

Error rates from each condition appear in the base of bars depicting RTs from that condition (see Figures 5 & 6). We transformed accuracy values via an arcsine square-root transformation as in the previous experiments. We then submitted the transformed accuracies to the same 2x2x2 repeated measures ANOVA as the RTs. This ANOVA found no significant main effects, all $F$s < 1. The ANOVA also failed to find any significant interactions, all $ps > 0.21$. 
Again, we suspect that response terminated displays kept accuracy at ceiling, preventing us from finding any meaningful differences.

**Discussion**

In Experiment 2 we demonstrated that observers could learn to effectively reject novel color-singletons even with previous homogeneous distractor experience. With Experiment 3, we sought to clarify whether additional task experience or experience with a greater number of color-singleton identities enabled observers to immediately reject novel color-singleton distractors. Experiment 3 found that novel color-singletons in Block 5 distracted observers, but familiar color-singletons in Blocks 2-4 did not. Thus, unlike Experiment 2 where color singletons did not initially distract observers in Blocks 5, color singletons in the same block did initially distract observers in Experiment 3. Because the only difference between Experiments 2 and 3 is the number of color singletons previously experienced, the results suggest that experience with multiple color-singleton identities enabled observers in Experiment 2 to immediately reject novel color-singletons.

Before entering Blocks 5, observers performed 60 practice trials and four 144 trial blocks (636 total trials). This large amount of task experience did not prevent novel color singletons from distracting observers. The lack of distraction in Block 6 suggests that extensive task experience also might have some role in preventing novel color singletons from distracting observers, even without experiencing many distinct colors.

**General Discussion**

The experiments reported here sought to examine observers’ ability to reject novel, salient distractors when performing a relatively demanding visual search task. The experiments contribute to our understanding of the different factors that influence our ability to reject novel
but irrelevant items. Past work has demonstrated that task strategy influences our ability to effectively reject items: searching for specific targets does achieve distractor suppression whereas searching for unique items does not (Bacon & Egeth, 1994; Leber & Egeth, 2006). Previous work from our lab found observers also need item-specific distractor experience to effectively reject distractors (Vatterott & Vecera, 2012). The current experiments examined the conditions that enable observers to generalize rejection of certain distractors to novel distractors.

In Experiment 1, we examined how a heterogeneous distractor environment might enable observers to reject novel color-singleton distractors without previously experiencing these items. Previous work on learning demonstrated that heterogeneous stimulus environments encourage more generalizable skill learning (Schmidt & Bjork, 1992). We investigated whether learned distractor rejection shares this aspect of learning. Experiment 1 found heterogeneous distractor experience did enable observers to reject novel color-singleton distractors immediately (without practice), demonstrating that the temporal statistics of the stimulus environment is a critical factor to learning effective distractor rejection.

Experiments 2 and 3 examined the degree to which task experience and exposure to multiple singleton distractor identities is necessary for observers to immediately reject a novel color singleton distractor. Schneider and Shiffrin (1977; Shiffrin & Schneider, 1977) found extensive experience searching for the same targets among the same distractors enabled observers to immediately guide attention to the target. Although Schneider and Shiffrin never investigated whether novel distractors could disrupt attentional guidance, their work suggests that general task experience might enable observers to effectively reject distractors without previously experiencing them. We examined this possibility in a homogeneous distractor environment. Experiment 2 found that observers were able to effectively reject novel color
Experience and distractor rejection

singletons following four blocks with four different distractor colors. Either general task experience or experience with many different color-singleton identities could enable observers in Experiment 2 to immediately reject novel color-singletons. We designed Experiment 3 to distinguish between these possibilities and elucidate the conditions that enable observers to effectively reject novel color-singleton distractors. In Experiment 3, observers performed blocks 1-4 with the same color-singleton identity then experienced novel color-singletons in Blocks 5 and 6. These novel color-singletons in Block 5 initially distracted observers while novel color-singletons in Block 6 did not, indicating that experience with a greater number of color singleton identities and general task experience led to the suppression of novel color singletons in Experiment 2.

Our results have important implications for current theories of attentional control. Müller’s feature dimension weighting hypothesis (Müller, Heller, & Ziegler, 1995) claims that observers weight feature dimensions when selecting where to allocate attention. For example, when observers search for a specific shape, they place greater attentional priority on the shape dimension than color. A strict interpretation of Müller’s feature dimension weighting hypothesis predicts that once observers experience one color-singleton distractor, they should bias attentional priorities away from the color dimension and effectively reject all future color-singletons, but this is not the case (Zehetleitner, Goschy, & Müller, 2012; Vatterott & Vecera, 2012). Instead, observers must tune attention away from multiple color values. Experiment 1 qualified this and suggests trial-to-trial heterogeneity of distractor colors guides attentional priorities away from distractor colors generally. Taken together, Experiments 2 and 3 indicate that even with trial-to-trial homogeneity, extensive experience with more than four color-
Experience and distractor rejection

Experience and distractor rejection

Existing accounts of overcoming attentional capture can be reconciled with the current set of results. For instance, Theeuwes (1992) postulated that distractors more salient than the target always capture attention (for review see Theeuwes, 2010). Observers then redirect attention towards task-relevant items by **disengaging** attention from distractors. It is possible that observers increase disengagement speeds as they gain experience with salient distractor identities. The current set of results allow for experience-dependent changes in disengagement speeds. Folk and Remington (1998) proposed that salient items do not capture attention. Instead, salient distractors compete for attention, slowing the allocation of attention to the target, and extending RTs. It is possible that experience with a distractor reduces salient distractors’ ability to compete for attention. There have also been multiple demonstrations of priming in attentional control, (Kristjánsson & Campana, 2010; Lamy, Carmel, Egeth, & Leber, 2006; Olivers & Humphreys, 2003; Pinto, Olivers, & Theeuwes, 2005). We believe our results are consistent with these rapid experience-dependent changes in attentional control since a novel salient distractor is also a distractor that has not been encountered in the recent past. Although, we note that the influence of a heterogeneous distractor environment and of experiencing many previous salient color singletons operates on a much longer time scale than typically seen in priming.

Horstmann’s (2002, 2005) work on novelty and attentional capture compliments our results. In these papers, Horstmann demonstrates a novel item’s power to capture observers’ attention. We believe our results derive from a similar mechanism. Horstmann proposed the expectancy match hypothesis (Horstmann 2005; Becker & Horstmann, 2011), which posits that unexpected items automatically capture observers’ attention. Experiment 1 compliments
Horstmann’s results by demonstrating that a heterogeneous distractor environment changes observers’ expectancies such that novel color-singletons are no longer unexpected. Experiments 2 and 3 found experiencing more than four color-singleton distractors has the same effect.

Baldi and Itti (2010) proposed that Bayesian expectations could determine stimulus saliency. Under this account, more unexpected events are more salient. This model improves upon other models of saliency by quantifying saliency as not only the uniqueness of an item within a single image (Itti & Koch, 2000), but also as the uniqueness of an item across images. A model such as Baldi and Itti’s would likely produce similar results as those seen here. In Experiment 1, the heterogeneous environment could decrease the system’s expectations of what salient distractors might appear in the future and thus create less of an expectancy violation when a novel color-singleton appears. Also experiencing a multitude of different color-singleton identities might make the model less “surprised” when it experiences yet another novel color-singleton. However, purely rational accounts such as Baldi and Itti (2010) have a challenge in explaining the volume of practice that is needed for altering expectations.

Our results combine with the growing literature demonstrating that experience plays a substantial role in attentional control. Each experiment presented here adds important understanding to this literature. For instance, Experiment 1 demonstrates the role of learning context in experience's influence on attentional control. Experiments 2 and 3 then specify how distractor experience influences attentional control. Specifically, experiencing a multitude of different salient distractor identities encourages observers to strengthen goal-driven inputs to attentional control. This demonstration supports the idea we have promoted in past work (Wilder, Mozer, & Wickens, 2011; Vecera et al., 2014) that attentional control is not a monolithic system that always biases attention towards either salient or task-relevant items,
which tends to be the dominant view in the literature. Instead, the attentional control system is always in a state of flux, constantly adjusting to maximize success, whether success is defined by an explicit reward (e.g., Anderson, Laurent, & Yantis, 2011), or by intrinsic measures such as efficiency in discriminating targets from distractors.
References


Acknowledgments

This research was supported in part by grants from the National Science Foundation (BCS 11-51209) and by research contracts from the Nissan Motor Corporation and the Toyota Collaborative Safety Research Center (CSRC). Correspondence should be addressed to Shaun Vecera at Department of Psychological and Brain Sciences, W311 Seashore Hall, University of Iowa, Iowa City, IA 52242-1407. Electronic mail can be sent to shaun-vecera@uiowa.edu.
Experience and distractor rejection

Figure Captions

Figure 1. The left panel depicts the sequence of events for the Experiment 1 Blocked group. A 1,000 ms fixation dot preceded each search display (not pictured). The search display appeared on the screen for 5,000 ms or until response. Color-singleton distractors appeared in 50% of the trials. The color-singleton's color changed each block. The right panel depicts the sequence of events for the Experiment 1 Mixed group. A 1,000 ms fixation dot preceded each search display (not pictured). The search display appeared on the screen for 5,000 ms or until response. Color-singletons distractors appeared in 50% of the trials. Three different color-singletons appeared intermixed within each of the first three blocks. A single novel color-singleton appeared in Block 4.

Figure 2. The upper panel depicts Blocked group RTs (in milliseconds) from Blocks 1-3 as a function of Trial Position (first half of the block versus second half of the block) and singleton presence (singleton present versus singleton absent). The lower panel depicts Mixed group RTs (in milliseconds) as a function of block (Blocks 1, 2, & 3) and singleton presence (singleton present versus singleton absent). Error rates from each condition appear in the base of each bar. Error bars represent 95% within-subject confidence intervals (Loftus & Masson, 1994; Baguley, 2012).

Figure 3. Experiment 1 RTs (in milliseconds) from Block 4. The upper panel depicts RTs from Block 4 of the Blocked group as a function of Trial Position (first half of the block versus second half of the block) and singleton presence (singleton present versus absent). The lower panel depicts RTs from Block 4 of the Mixed group as a function of Trial Position and singleton presence. Error rates appear in the base of the bars. Error bars represent 95% within-subject confidence intervals (Loftus & Masson, 1994; Baguley, 2012).
Figure 4. Experiment 2 response times (in milliseconds). The upper panel depicts response times as a function of trial order (Early Trials versus Late Trials) and singleton presence (singleton present versus singleton absent) across Blocks 1-4. Early Trials are the first twelve trials with a color-singleton and the first twelve trials without a color-singleton. Late Trials are all trials after the Early Trials. The lower panel depicts response times as a function of trial order and singleton presence across Blocks 5-6. Error bars represent 95% within-subject confidence intervals (Loftus & Masson, 1994; Baguley, 2012).

Figure 5. Experiment 3 response times (in milliseconds). The upper panel depicts response times as a function of trial order (Early Trials versus Late Trials) and singleton presence (singleton present versus singleton absent) across Blocks 1, 5, & 6 (when observers experienced novel color singleton distractors). Early Trials are the first twelve trials with a color-singleton and the first twelve trials without a color-singleton. Late Trials are all trials after the Early Trials. The lower panel depicts response times as a function of trial order and singleton presence across Blocks 2, 3, & 4 (when observers did not experience novel color singleton distractors). Error bars represent 95% within-subject confidence intervals (Loftus & Masson, 1994; Baguley, 2012).

Figure 6. Experiment 3 response times (in milliseconds). The upper panel depicts response times as a function of trial order (Early Trials versus Late Trials) and singleton presence (singleton present versus singleton absent) in Block 5. Early Trials are the first twelve trials with a color-singleton and the first twelve trials without a color-singleton. Late Trials are all trials after the Early Trials. The lower panel depicts response times as a function of trial order and singleton presence in Block 6. Error bars represent 95% within-subject confidence intervals (Loftus & Masson, 1994; Baguley, 2012).
FIGURE 1

Blocked Group

Block 1 (Trials 1-48)
Color Singleton 1

Block 2 (Trials 49-97)
Color Singleton 2

Mixed Group

Blocks 1-3
Color Singletons 1, 2 & 3

Block 4
Color Singleton 4
Experiment 1

Blocked Group; Block 4

Response Times (ms)

1st Half of Block | 2nd Half of Block
1.56% | 4.17% | 4.17% | 2.60%

Mixed Group; Block 4

Response Times (ms)

1st Half of Block | 2nd Half of Block
4.17% | 2.08% | 3.66% | 6.17%
Experiment 2

Blocks 1-4

Response Times (ms)

Early Trials | Late Trials
---|---
2.31% | 2.08%
2.99% | 2.75%

Blocks 5-6

Response Times (ms)

Early Trials | Late Trials
---|---
3.70% | 3.47%
3.33% | 3.16%

Legend:
- Singleton Present
- Singleton Absent
Experiment 3
Blocks 1, 5, & 6

Response Times (ms)

<table>
<thead>
<tr>
<th>Trials</th>
<th>5.56%</th>
<th>5.56%</th>
<th>5.48%</th>
<th>5.54%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Blocks 2-4

Response Times (ms)

<table>
<thead>
<tr>
<th>Trials</th>
<th>7.56%</th>
<th>5.40%</th>
<th>4.95%</th>
<th>5.29%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Singleton Present
Singleton Absent
FIGURE 6

Experiment 3
Block 5

[Bar chart showing response times in milliseconds for early and late trials in Block 5, with data points of 4.17% and 4.95% in black, and 1.85% and 4.95% in white.]

Block 6

[Bar chart showing response times in milliseconds for early and late trials in Block 6, with data points of 4.17% and 4.99% in black, and 4.17% and 4.84% in white.]