Review article

The past, present, and future of selection history

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ABSTRACT

The last ten years of attention research have witnessed a revolution, replacing a theoretical dichotomy (top-down vs. bottom-up control) with a trichotomy (biased by current goals, physical salience, and selection history). This third new mechanism of attentional control, selection history, is multifaceted. Some aspects of selection history must be learned over time whereas others reflect much more transient influences. A variety of different learning experiences can shape the attention system, including reward, aversive outcomes, past experience searching for a target, target–non-target relations, and more. In this review, we provide an overview of the historical forces that led to the proposal of selection history as a distinct mechanism of attentional control. We then propose a formal definition of selection history, with concrete criteria, and identify different components of experience-driven attention that fit within this definition. The bulk of the review is devoted to exploring how these different components relate to one another. We conclude by proposing an integrative account of selection history centered on underlying themes that emerge from our review.

1. The history of selection history

It has long been appreciated that the brain processes perceptual information selectively. Capacity limitations of the visual and auditory systems were evident from the beginnings of perception science (e.g., Broadbent, 1958; Cherry, 1953; Sperling, 1960), and there has been long-standing interest in what determines which information available to sensation is ultimately represented at capacity-limited stages of information processing. The process of selecting such information for representation serves as the foundation for formal definitions of the concept of *attention* (e.g., Desimone and Duncan, 1995; Jonides, 1981; Posner, 1980; Serences and Yantis, 2006; Treisman and Gelade, 1980; Wolfe, 1994). From very early on in attention research, two principle influences on the control of attention were evident, which came to serve as the cornerstones of theories of attention for decades to come.

1.1. The goal-directed versus stimulus-driven dichotomy: a brief overview

Endogenous, goal-directed influences on the control of attention have long been appreciated and more-or-less taken for granted in theories of attentional control. Observers can direct their attention to a location in space in anticipation of a target stimulus (e.g., Posner, 1980; Yantis and Johnston, 1990) and can selectively attend to one or a subset of multiple stimuli on the basis of task goals (e.g., Folk et al., 1992; Irons et al., 2012; Reynolds et al., 1999; Wolfe et al., 1989). To account for this apparent flexibility in control, most all formal theories of attention contain a goal-contingent component biasing selection at some stage of information processing (e.g., Awh et al., 2012; Bundesen, 1990; Desimone and Duncan, 1995; Serences and Yantis, 2006; Theeuwes, 2010; Wolfe, 1994, 2020). At the same time, physically salient (i.e., stimuli with a high feature contrast relative to their surroundings) have been shown to be preferentially attended in spite of their known irrelevance to the task at hand (e.g., Itti and Koch, 2001; Theeuwes, 1992, 1994; Yantis and Jonides, 1984). Since in this case attention appears to be driven by the properties of the stimulus, it can be said to be *stimulus-driven*. More controversial has been the issue of whether such goal-directed influences operate at early or late stages of attentional processing, and by extension whether the initial deployment of attention at the outset of stimulus processing is under the control of the observer (e.g., Eimer and Kiss, 2008, 2010; Theeuwes, 2010; Gaspelin and Luck, 2018).

Under certain circumstances, physically salient stimuli appear to be ignored unless they possess a goal-defining feature, such as the color of a sought target, suggesting that the initial deployment of attention is subject to goal-contingent control (e.g., Anderson and Folk, 2010, b; Folk et al., 1992, 2002; Eimer and Kiss, 2008, 2010; Lien et al., 2008,

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2010). Under other experiment conditions, however, physically salient but entirely task-irrelevant stimuli receive preferential attentional processing, suggesting that attentional selection is initially determined in a stimulus-driven fashion (e.g., Theeuwes, 1992, 1994; Yantis and Jonides, 1984). These apparently conflicting findings have led to an ongoing debate concerning which plays the more dominant role in the control of attention (e.g., Belopolsky et al., 2010; Connor et al., 2004; Folk and Remington, 2008; Theeuwes, 2010), although attempts to formally reconcile the apparently discrepant positions have been undertaken (e.g., Burnham, 2007; Gaspelin et al., 2015, 2017; Gaspelin and Luck, 2018; Hickey et al., 2009; Leber, 2010; Luck et al., 2021; Serences and Yantis, 2006). The debate between the goal-directed and stimulus-driven control of attention would come to dominate perspectives on attentional control throughout the 1990s and 2000s, although as will be discussed below, shortcomings with the very terms of the debate were evident even before it began.

It is worth noting that the aforementioned debate was often framed in the context of the terms *top-down* and *bottom-up* rather than *goal-directed* and *stimulus-driven*. Even before the concept of selection history, which overtly challenged the concepts of top-down and bottom-up (Awh et al., 2012), gained traction, Egeth and Yantis (1997) favored the terms *goal-directed* and *stimulus-driven* in their foundational work as more precise and less metaphorical, in some ways presaging the distinctions to come (see also Kinchla and Wolfe, 1979). In the tradition of Egeth and Yantis (1997), we favor the terms *goal-directed* and *stimulus-driven* in this review.

1.2. Early complexities with the dichotomy

Evidence inconsistent with the goal-directed/top-down versus stimulus-driven/bottom-up framework of attentional control was evident from the beginnings of attention research, although it would take quite some time for this dichotomous framework to be overtly challenged. One of the earliest examples of this conflicting evidence can be found in the domain of auditory attention, where the given name of a person was found to "break through" the attended stream in a dichotic listening task (Moray, 1959). Participants were not tasked with listening for their name, the volume of which was no greater than other sounds played to the unattended ear that showed no such breakthrough effect, making it difficult to argue that this breakthrough effect was either goal-related or stimulus-driven. It became a noted exception case, with the consensus becoming that self-referential information such as a person's own name had a privileged status in perception (e.g., Parise et al., 2010; Sui et al., 2012; Tacikowski and Nowicka, 2010; Wood & Cowen, 1995).

In foundational work on automaticity, Shiffrin and Schneider (1977) demonstrated automatic selection of a letter that had served as a consistent target of visual search. The letter had a history of being the object of goal-directed attention, but persisted in its ability to capture attention long after it ceased to serve as a target. Although the demonstration played an integral role in theories of automaticity, given the substantial amount of training involved in producing the effect and paradigmatic differences between the study and more typical selective attention tasks, the relationship between the observed automaticity and the control of attention remained unclear and subsequent theories of the control of attention generally overlooked the phenomenon. This persisted even after Kyllingsbaek et al. (2001, 2014) demonstrated the same effect using a more traditional attentional capture paradigm, which to some degree reinvigorated the demand to explain the phenomenon in attentional terms (see also Qu et al., 2017).

On the other end of the spectrum from target history effects is the role of novelty in the control of attention. Infrequently encountered stimuli were shown to be preferentially attended, suggesting a bias to orient to the unexpected or unusual (e.g., Johnston et al., 1990, 1993; Johnston and Schwarting, 1997). As with the initial demonstration of target-history effects (Shiffrin and Schneider, 1977), the experimental

procedures used to demonstrate the phenomenon differed somewhat from typical selective attention tasks, which coupled with the complex nature of the phenomenon (Johnston and Schwarting, 1997), may have similarly contributed to its minimal influence on the goal-directed versus stimulus-driven debate. Later findings demonstrating clear biases for novel stimuli in more conventional attentional control paradigms (Folk and Remington, 2015; Horstmann and Ansorge, 2006, 2016; Horstmann and Herwig, 2016; Horstmann, 2002; Neo and Chua, 2006; Retell et al., 2015), reinvigorated interest in the phenomenon, although such interest largely proceeded as a parallel line of attention research and, perhaps given the link between novelty and sensory habituation (e. g., Sokolov, 1975; Vankov et al., 1995) along with the rapid-trial design feature of most attention paradigms, was generally categorized as consistent with the modulation of a bottom-up phenomenon (see, e.g., Folk and Remington, 2015; Neo and Chua, 2006).

Threatening or aversive stimuli were shown to be very effective as distractors, impairing performance in a visual task to a greater extent than affectively neutral stimuli (e.g., Most et al., 2005; Most and Wang, 2011; Mulckhuyse, 2018; Öhman and Mineka, 2001; Vuilleumier, 2005). Similar effects were shown for highly arousing stimuli with positive valence (Most et al., 2007; Pool et al., 2016). Long-standing debates surrounded the extent to which such effects reflected evolved mechanisms of learning-independent priority, feature properties of the valent images, orienting effects influenced by congruence with current emotional state (which is itself influenced by the processing of the images), and/or voluntary mechanisms of control centered on the interest level of the stimuli (e.g., Abado et al., 2020; Brown et al., 2020; Devue et al., 2011; Öhman and Mineka, 2001; Vromen et al., 2016). Given these controversies, discussions surrounding the goal-directed versus stimulus-driven control of attention progressed with very little effort to explicitly reconcile such threat-related biases.

Above-and-beyond target history, long-term memory has long been known to play a role in the control of attention, even when observers are not consciously aware of the contingencies that influence their orienting. One prominent example of this is contextual cueing, where the spatial arrangement of distractors can guide attention more efficiently to an associated target location (e.g., Chun and Jiang, 1998, 2003; Jiang and Wagner, 2004). Another example is predictable statistical regularities, whereby attention tends to be drawn toward regions of a scene where a predictable sequence of events occurs compared to regions where events occur in random sequence (Yu and Zhao, 2015; Zhao et al., 2013; Zhao and Luo, 2017). Observers tend to also persist in the use of a particular attentional strategy once learned (Leber and Egeth, 2006a, b; Leber et al., 2009), and can do so in a contextually-specific matter (Cosman and Vecera, 2013; see also Sali et al., 2015). Such findings are consistent with the idea of memory-based attentional guidance (Hutchinson and Turk-Browne, 2012). Although these memory-driven biases did not appear to be strategic, often occurring without conscious awareness, the fact that such biases were not explicitly counter-productive (Yu and Zhao, 2015; Zhao et al., 2013), and in some cases facilitated optimal task performance (Chun and Jiang, 1998, 2003), did not pose an overt challenge to the goal-directed versus stimulus-driven dichotomy and research into the phenomenon progressed largely in parallel to debates concerning the goal-directed versus stimulus-driven control of attention.

Inter-trial priming, whereby recent selection of a stimulus biases attention on subsequent trials (e.g., Kristjansson, 2006; Maljkovic and Nakayama, 1994, 1996; Treisman, 1992), has a rich history in the attention literature (see Kristjansson and Campana, 2010, for a review) and factored heavily into the argument that the goal-directed versus stimulus-driven dichotomy was insufficient to explain the extent of findings in the attention literature (Awh et al., 2012). That it took so long for the phenomenon to be discussed as reflecting a separate source of attentional control may extend from the fact that inter-trial priming has traditionally been conceptualized as a modulation of stimulus-driven attentional priority and was frequently invoked by

proponents of a stimulus-driven account of attention as a counter-argument for goal-contingent selection, which could be conceptualized as a build-up of frequent priming when the target-defining feature is held constant over trials (Belopolsky et al., 2010; Theeuwes, 2010, 2013).

1.3. The selection history revolution

Effects of reward on attention were noted well before the selection history movement. However, such effects were often placed within the framework of motivated attention (e.g., Esterman et al., 2014, 2016; Navalpakkam et al., 2009, 2010; Pessoa, 2009; see also Bucker and Theeuwes, 2014), which has natural parallels with goal-directed or top-down attention. Neuroimaging findings affirmed this element of reward-related processing in the control of attention, with reward-associated stimuli linked to enhanced activation of the dorsal attention network (Esterman et al., 2017; Jimura et al., 2010; Etzel et al., 2016; Locke and Braver, 2008; Padmala and Pessoa, 2011; Pessoa and Engelmann, 2010; Small et al., 2005).

A wave of new studies began to question whether motivation-related influences on goal-directed attention provided a complete account of reward-related influences. Reward-related stimuli were linked to stronger activation within the visual system (Kiss et al., 2009; Kristjansson et al., 2010; Serences and Saproo, 2010; Shuler and Bear, 2006), with reward history serving as a better predictor of visually-evoked activity than participants' actual choices in a decision-making task (Serences, 2008). The elevated attentional priority of reward-associated stimuli could persist well after reward contingencies were removed (i.e., persist into extinction), with reward-associated stimuli competing more effectively for selection (Della Libera and Chelazzi, 2009; Della Libera et al., 2011; Peck et al., 2009) and being less subject to the attentional blink (Raymond and O'Brien, 2009). The receipt of reward was also shown to modulate the magnitude of inter-trial priming, with priming on the subsequent trial being greater following receipt of a high reward (e.g., Hickey et al., 2010a, b, 2011). Such findings were not in direct conflict with the goal-directed versus stimulus-driven dichotomy, although reward-based modulations of goal-directed influences did not appear to provide a parsimonious explanation.

It was in the context of reward history that the goal-directed versus stimulus-driven dichotomy was overtly challenged. Anderson et al. (2011b) designed an experiment in which a previously reward-associated stimulus was entirely task-irrelevant and physically non-salient, being less salient than the target of visual search. Under these conditions, then extant theories of attentional control clearly predicted that the attentional priority of the previously reward-associated distractor should be no greater than any other non-target present in the display. That a previously reward-associated distractor robustly drew attention (see also Anderson et al., 2011a; Anderson and Yantis, 2012) and effectively competed for selection with a more physically salient and task-relevant stimulus (target) demanded an explanation that current theories attributing attentional bias to a combination of goal-directed and stimulus-driven inputs could not provide, leading the authors to conclude that attention could be *value-driven* (Anderson, 2013; Anderson et al., 2011b). Influenced heavily by reward-dependent effects and the phenomenon of inter-trial priming, the aforementioned findings collectively led Awh et al. (2012) to conclude that the top-down (goal-directed) versus bottom-up (stimulus-driven) dichotomy was insufficient to account for the literature that had emerged on the control of attention, and they introduced the concept of *selection history* as a third control mechanism to resolve the apparent conflict.

Attentional biases similar to those for naturally threatening stimuli were shown to extend to otherwise neutral stimuli conditioned with an aversive outcome such as a loud white noise burst (e.g., Koster et al., 2004a; Smith et al., 2006), suggesting that such biases could themselves develop through learning. However, perhaps due in part to the

long-standing controversies surrounding threat-related attentional biases mentioned above, such findings did not feature into the motivation for introducing the concept of selection history (Awh et al., 2012), although the formalization of selection history reinvigorated interest in understanding these biases, including their demonstration in traditional attentional capture tasks (Schmidt et al., 2015a, b; Wang et al., 2013). In the wake of Awh et al.'s coining the term, such learned threat-based orienting effects were quickly grouped with other learning-dependent influences as reflecting a unique influence of selection history on attention, which came to be frequently invoked in theoretical accounts of any learning-dependent influence on the control of attention.

2. The ghost of selection history present

Since their landmark paper (Awh et al., 2012), the term "selection history" has appeared frequently in discussions of findings in the attention literature, already eclipsing 1,000 citations in Google Scholar. As influential as the concept has become, very little effort has been taken to formally integrate phenomena attributed to selection history into a comprehensive mechanistic account. Rather, what we will call different *components of experience-driven attention*, such as reward history, aversive conditioning, history as a sought target, etc., are often studied and discussed either in isolation (e.g., Anderson et al., 2011a, b; Della Libera and Chelazzi, 2009; Kyllingsbaek et al., 2001, 2014; Schmidt et al., 2015a, b) or within a narrow scope comparing two components (e.g., Kim & Anderson, 2019a, ; Wang et al., 2013; Wentura et al., 2014). Neither has there been an explicit discussion concerning what exactly constitutes selection history as it applies to the control of attention. Awh et al. (2012) offered reward history and inter-trial priming as two examples of selection history, focusing predominantly on the inadequacy of the top-down/goal-directed versus bottom-up/stimulus-driven dichotomy as a framework. However, references to the concept of selection history have routinely appeared in the context of attention to learned signals of threat (e.g., Failing & Theeuwes, 2018; Nissens et al., 2017), prior experience searching for a target stimulus (e.g., Kim and Anderson, 2019a, ; Sha and Jiang, 2016; Stankevich and Geng, 2014), and prior experience rejecting distractor stimuli (e.g., Theeuwes, 2019; Goschy et al., 2014; Leber et al., 2016; Sauter et al., 2019; Wang and Theeuwes, 2018a, b, c), showing a clear willingness in the field to interpret the term more broadly. In this review, we will use the term *selection history* to refer to the theoretical mechanism of attentional control as an overarching concept, following the term introduced by Awh et al. (2012), and *experience-driven attention* to refer to specific cases of information processing for which selection history is believed to provide a more suitable explanation than goal-directed or stimulus-driven processes (see Table 1). This distinction will become useful when we explore the diversity of learning experiences and resulting attentional biases that collectively comprise the whole of selection history, as we will ultimately conclude that selection history comprises more than one distinct underlying mechanism of attentional control.

As frequently as the concept is invoked, it seems that the literature on selection history suffers from a fundamental flaw. We would argue that

Table 1
Key terms and definitions.

Term	Definition
Selection history	Prior experience, broadly construed, that exerts a direct influence on the control of attention. This term captures an overarching theoretical construct in attentional control.
Experience-driven attention	A specific instance in which prior experience exerts a direct influence on the control of attention; in such cases, attention can be said to be experience-driven. A key assertion in this review is that different kinds of experience-driven attention, referred to as *components*, collectively comprise selection history.

selection history has become a bit of a "ghost" concept in the attention literature. People talk about it as if it were a real thing, but it lacks substance. Most every attention researcher has an intuition about what selection history is, but explicit formalizations of the concept are lacking, creating an environment ripe for confusion. In this review, we make an effort to summarize what has become a vast literature on selection history, with an eye toward integration. Our hope is that this review will serve as the starting point in an effort to define what lies inside the third box labeled "Selection History" in Awh et al.'s priority map model (2012, their Figure 2) and understand how the different pieces in that box fit together. In our effort to do this, we tackle what we believe to be key questions in research into selection history, balancing our perspective between what we have learned and what we have yet to learn as a field with respect to the answers.

2.1. What constitutes selection history?

2.1.1. Definition

In order to have a productive discussion about selection history, we have to first delineate what exactly falls under our definition of the term. To borrow from the language we introduced in the prior section, we need to define what the components of experience-driven attention are (see Table 1). Before we can define these components, however, we must first clearly define the criteria that a candidate component must meet in order to qualify as a case of experience-driven attention. In the following section, we outline three core criteria that we believe reflect a useful starting point for an integrative account of selection history. Given that this is an initial attempt at bridging an often compartmentalized literature, we err on the side of what we believe to be a liberal definition, which can be later refined to be more exclusive and nuanced, facilitating future discussion and debate concerning where exactly the boundary conditions for distinguishing between selection history and other mechanisms of attentional control should be placed.

1) *Dependent upon prior experience with stimuli.* The influence of past episodes in which sensory information was processed is at the core of the concept of selection history. Here, we consider both past experience that involves some learning-dependent change in the manner in which stimulus input is prioritized within the attentional system as well as more passive and transient influences of past experience such as inter-trial priming, although we explore possible distinctions between such influences later in the manuscript.

2) *Cannot be reduced to an effect of prior experience on goals and intentions.* One of the ways in which past experience can influence attention is through updating our goals and intentions. If we learn that something is important, we can voluntarily try harder to monitor for it or otherwise strategically shift our attentional priorities in order to more efficiently produce a desired outcome. Although this is clearly a case of experience-*dependent* attention, the prior experience is not having a direct influence on attention but rather an indirect influence via goal-directed mechanisms of control (see Anderson, 2013, 2018). Here, we limit our definition of selection history to direct influences, hence the term experience-*driven*, and explore some considerations stemming from this definition below (see esp. Section 2.2).

3) *Can be applied to an arbitrary stimulus.* In order to definitively conclude that the allocation of attention is a consequence of selection history, it must be the product of prior experience with stimuli that is empirically tractable. There are certain classes of stimuli, for example, spiders, snakes, and erotica, that may under certain conditions have high attentional priority without any explicit learning manipulation (e.g., Brown et al., 2020; Devue et al., 2011; Most et al., 2005, 2007; Most and Wang, 2011; Mulckhuyse, 2018; Öhman and Mineka, 2001; Pool et al., 2016; Vromen et al., 2016). Although attention to such stimuli may be, at least in part, influenced by prior experience with these stimuli that people have in their everyday life, it could also be influenced by specific features of these stimuli or

evolutionarily conserved mechanisms of information processing that prioritize such stimuli (e.g., Farroni et al., 2005; Goren et al., 1975). If the underlying mechanism of attentional prioritization is indeed dependent upon selection history, it should be capable of being applied to any stimulus that meets the necessary history criteria (such as pairing with a rewarding or aversive outcome); as such, we only consider cases in which the experiential history that drives attention is itself explicitly manipulated in the context of an experiment.

2.1.2. Applying the definition

In considering how prior experience could influence the computation of attentional priority, it is important to consider the full breadth with which perceptual input can be characterized. This includes the elementary features of stimuli such as color and shape, particular spatial positions where stimuli can be encountered, relational properties present in the environment such as the spatial arrangement of objects, and abstracted properties such as the frequency of encountering particular objects across multiple exposures to an environment. As will be argued, mechanisms of experience-driven attention operate across these levels of representation.

Applying our three criteria, the following phenomena would qualify as components of experience-driven attention (Table 2) that collectively comprise selection history. We do not intend for this to reflect a comprehensive list describing the full breadth of selection history and instead focus on the most empirically supported components of experience-driven attention that will serve as the foundation for our conceptualization of selection history in the remainder of our review. Each of the components that we identify here will be expounded upon thematically in the sections to follow.

1) *History as a sought target.* Orienting attention to a target stimulus repeatedly over trials creates a persistent bias to orient attention to stimuli possessing target-defining features on subsequent trials (e.g., Kyllingsbaek et al., 2001, 2014; Lin et al., 2016; Miranda and Palmer, 2014; Qu et al., 2017; Sha and Jiang, 2016; Shiffrin and Schneider, 1977). This bias can develop when there is no explicit incentive to orient to the target during a learning phase, other than the desire to follow task instruction, and when previously target-defining features appear as task-irrelevant distractors in a later phase of the experiment (e.g., Kyllingsbaek et al., 2001, 2014; Sha and Jiang, 2016).

2) *Association with rewarding outcomes.* Stimuli that reliably predict a reward can acquire elevated attentional priority (e.g., Anderson

Table 2
Components of experience-driven attention with examples for context.

Component	Examples
History as a sought target	A stimulus feature that consistently defines the target and is useful for localizing the target over repeated trials
Reward history	Associations between stimulus features or complex objects and reward (monetary gain, liquid reward, positive social feedback, etc.)
Punishment history	Associations between stimulus features or complex objects and aversive outcomes (electric shock, monetary loss, loud noises, negative social feedback, etc.)
Statistical dependencies among objects	The spatial relationship among targets and non-targets, the sequence in which objects are presented in succession
Statistical dependencies in object location	Locations at which targets or distractors frequently appear over trials
Stimulus frequency	Features that more frequently define targets and/or distractors over trials, stimuli that are infrequent (novel) in the current context
Inter-trial priming	When target and/or distractor features repeat over trials, resulting in a repetition in the attentional demands of the task

et al., 2011b; Della Libera and Chelazzi, 2009). Even with history as a former target equated (e.g., Anderson and Halpern, 2017; Kim & Anderson, 2019a) or when the reward-predictive stimulus only ever serves as a task-irrelevant distractor (e.g., Bucker and Theeuwes, 2017; Le Pelley et al., 2015; Pearson et al., 2015), stimuli that predict higher-value outcomes compete more effectively for attention than stimuli that predict less or no reward. The effect of learned value on attention can be observed even when previously reward-associated stimuli appear as task-irrelevant distractors and when rewards are no longer delivered to motivate performance (e.g., Anderson et al., 2011a, b; Anderson and Halpern, 2017). There is some evidence that reward can similarly bias attention to spatial locations at which identification of a target is more highly rewarded (Chelazzi et al., 2014; Della Libera et al., 2017), although there are limitations to the scope of this bias (Jiang et al., 2015a; Won and Leber, 2016) and it may operate differently than the influence of reward on stimulus features (see Anderson and Kim, 2018a, b), which is a possibility that we will return to later in the paper.

3) *Association with aversive outcomes.* Much like with previously reward-predictive stimuli, stimuli previously associated with aversive outcomes such as monetary loss (e.g., Wang et al., 2013; Wentura et al., 2014), aversive noises (Koster et al., 2004a; Smith et al., 2006), and electric shock (e.g., Anderson and Britton, 2020; Nissens et al., 2017; Schmidt et al., 2015a, b) capture attention even when appearing as task-irrelevant distractors during an extinction phase (where the aversive outcome is no longer delivered).

4) *Learned statistical dependencies among objects.* Observers are sensitive to the relationships among objects that repeat over trials, which can exert an influence over the guidance of attention. A prominent example of such guidance is contextual cueing, whereby the spatial configuration among non-targets guides attention to an associated target location (e.g., Chun and Jiang, 1998, 2003; Jiang and Wagner, 2004). Such guidance appears to be largely implicit (e.g., Chun and Jiang, 2003; Colagiuri and Livesey, 2016), suggesting that it does not reflect a strategic goal-directed effect. Likewise, attention appears to be biased towards regions of a display at which predictable sequences of objects occur compared to regions associated with un-predictable sequences, suggesting that attention is drawn toward the presence of regularities in the environment, a bias that may aid in the learning of such regularities (Yu and Zhao, 2015; Zhao et al., 2013). When a context has been paired with a particular stimulus in a prior memory task, the presenting of this context produces an attentional bias toward the associated stimulus (Nickel et al., 2020; see also Fan and Turk-Browne, 2016)

5) *Learned statistical dependencies in object location.* When the target of visual search appears frequently in a particular spatial location, attention is biased toward this location, facilitating search when it appears in a high-probability region (e.g., Geng and Behrmann, 2002, 2005; Jiang, 2018; Jiang et al., 2013b, 2015a; Jiang and Swallow, 2013; Stankevich and Geng, 2014; Won and Leber, 2016). Participants can even track predictable changes in the likely location of a target over trials (Li and Theeuwes, 2020). This bias can occur when participants are unaware of the underlying spatial contingency, consistent with a non-strategic effect (Jiang et al., 2013b; Jiang and Swallow, 2013). Likewise, distractors are more efficiently ignored when appearing at locations at which distractors appear more frequently (e.g., Britton and Anderson, 2020; Goschy et al., 2014; Leber et al., 2016; Sauter et al., 2019; Wang and Theeuwes, 2018a, b, c), also without apparent awareness of the distractor–location contingencies (e.g., Failing et al., 2019a, b; Leber et al., 2016; Wang et al., 2019a; Wang and Theeuwes, 2018a). Neither effect can be attributed solely to inter-trial priming and therefore appears to reflect genuine learning of the underlying statistical structure of the stimulus displays over trials (e.g., Britton and Anderson, 2020; Jiang et al., 2013b; Jiang and Swallow, 2013; Wang and Theeuwes, 2018a, b, c).

6) *Stimulus frequency.* Under certain conditions, attention is biased toward stimuli that are encountered infrequently in the task (e.g., Folk and Remington, 2015; Neo and Chua, 2006) or have not previously been encountered (Horstmann and Ansorge, 2006, 2016; Horstmann and Herwig, 2016; Horstmann, 2002; Johnston et al., 1990, 1993; Johnston and Schwarting, 1997; Retell et al., 2015), reflecting a bias to orient to novel stimuli. At the same time, under other conditions attention can be biased toward features that more frequently define the target when multiple targets are used, in a manner that is not reducible to inter-trial priming or voluntary search strategy (Cosman and Vecera, 2014). Participants can also come to efficiently ignore frequent distractor features (e.g., Failing et al., 2019a; Stilwell et al., 2019; Vatterott and Vecera, 2012). Whether attention is biased toward novel or frequent stimuli may depend on whether the infrequent stimulus is task-relevant or task-irrelevant, leveraging contingencies to more efficiently guide attention to targets while simultaneously scrutinizing unexpected events, reflecting complementary biases towards exploration and exploitation (Hills et al., 2015).

7) *Priming.* Selecting a stimulus on one trial biases attention toward that stimulus on the next trial (Kristjansson, 2006; Kristjansson et al., 2002; Maljkovic and Nakayama, 1994, 1996; Treisman, 1992; Wang et al., 2005), whereas rejecting or ignoring a stimulus on one trial biases attention away from that stimulus on the next trial (Geyer et al., 2006; Kristjansson and Driver, 2008; Lamy et al., 2008; Maljkovic and Nakayama, 1994). Essentially, observers are biased to repeat recent patterns of attention allocation. Such priming effects can be observed even when the participant knows that the target-defining feature is likely to switch across trials, making the priming effect explicitly non-strategic (Hillstrom, 2000; Maljkovic and Nakayama, 1994). The strength of the priming effect is modulated by the reward received for selecting the target on a given trial (e.g., Hickey et al., 2010a, b, 2011; see also Della Libera and Chelazzi, 2006).

2.2. How is selection history related to task goals and physical salience?

As described above in our definition of attentional phenomena that constitute a case of selection history, such experience-driven orienting cannot be reducible to an influence of past experience on current goals. There is now substantial evidence that each of the components of experience-driven attention outlined above can be dissociated from the influence of current goals. Stimuli rendered in a previously reward-associated color capture attention even when rewards are no longer available, the color of stimuli is completely task-irrelevant, and the target never appears in the previously reward-associated color (e.g., Anderson et al., 2011b, 2020; Anderson and Halpern, 2017; Anderson and Yantis, 2012; Watson et al., 2019b). When a stimulus is both task-relevant and reward-related, these two influences have additive effects on visually-evoked responses in the brain, consistent with independent influences (Hopf et al., 2015). Even when always task-irrelevant, a reward-predictive distractor will come to capture attention in a manner that scales with the amount of reward it is associated with, suggesting that signals for reward capture attention regardless of task goals (e.g., Bucker and Theeuwes, 2017; Le Pelley et al., 2015; Pearson et al., 2015). Stimuli previously associated with aversive outcomes, such as mild electric shock, similarly capture attention when appearing as a task-irrelevant distractor (e.g., Schmidt et al., 2015a), and participants will preferentially orient to such stimuli even when doing so directly causes the aversive event the stimulus is associated with (Anderson and Britton, 2020; see also Nissens et al., 2017). A similar case can be made with respect to each of the other components of experience-driven attention described above. For example, repeated non-target configurations impair search when the familiar target position is changed (Brockmole and Henderson, 2006a; Manginelli and Pollman, 2009) and inter-trial priming effects can be

observed even when participants know that the target feature is likely to change trial-to-trial (Hillstrom, 2000; Maljkovic and Nakayama, 1994), although expectations concerning target and distractor features does play some modulatory role (Shurygina et al., 2019).

With that said, there is also clear evidence that goal-directed attention shapes selection history effects. Prominently, although former-target features can capture attention even when currently known to be task-irrelevant, their attentional priority is by definition contingent upon prior task goals (Anderson et al., 2011b; Anderson and Halpern, 2017). Recent evidence suggests that attentional biases driven by experience searching for a particular target stimulus are not specific to the target-defining feature per se but rather the computation of relative feature values that guide attention in this context (Liao et al., 2020a), consistent with the perseverance of something akin to a task set or search template (see Becker, 2010; Becker et al., 2010, 2013; Cosman and Vecera, 2013; Leber and Egeth, 2006a, b; Leber et al., 2009). In addition, effects of learned statistical dependencies in object location are often intertwined with task goals during acquisition. For example, high-probability target locations are learned through voluntarily directing attention to the target location (Geng and Behrmann, 2002, 2005; Jiang et al., 2013b, 2015a; Jiang and Swallow, 2013) and familiar configurations of non-targets in contextual cueing are necessarily paired with target locations to which attention is voluntarily directed, thereby linking these configurations with a pattern of goal-directed orienting (Chun and Jiang, 1998, 2003; Jiang and Wagner, 2004). In this sort of way, goal-directed attentional processes shape how attention is directed in the future via selection history, potentially gating what the learning mechanisms responsible for selection history-related influences have access to and/or transforming goal-directed orienting responses into a stimulus-triggered habit (a possibility we will return to later). Further consistent with the former possibility, contextual cueing is stronger for stimuli appearing in a task-relevant color during learning (Jiang and Chun, 2001), although some learning tied to task-irrelevant information has also been observed (Jiang and Leung, 2005).

In many early demonstrations of value-driven attentional capture, previously reward-associated stimuli also served as sought targets during reward learning. That is, participants were rewarded for voluntarily orienting to particular targets. As will be described in more detail in a later section, it has since become clear that in this sort of situation, the resulting attentional capture by previously reward-associated targets reflects a combination of value-dependent and former-target-dependent influences (e.g., Anderson and Britton, 2019; Kim & Anderson, 2019a, c; Anderson et al., 2017a). For example, value-driven attention results from predictive relationships between stimuli and reward above-and-beyond motivational influences of reward on goal-directed attention during learning (Sali et al., 2014), attention is captured more robustly by higher-value stimuli with equal status and exposure as a former target (e.g., Anderson, 2015a, b, 2016a; Anderson and Halpern, 2017; Anderson and Kim, 2019a, b; Anderson and Yantis, 2013; Anderson et al., 2011a, 2012, 2016c; Failing and Theeuwes, 2014; Grégoire et al., 2021a; Hickey and Peelen, 2015; Jiao et al., 2015; Kim & Anderson, 2019a, ; Marchner and Preuschhof, 2018; Mine and Saiki, 2015; Roper et al., 2014; Roper and Vecera, 2016; Theeuwes and Belopolsky, 2012), and most prominently, value-based orienting can be dissociated from the goal-directed orienting response that participants had to execute to obtain the reward (Kim & Anderson, 2019a). By comparing differential attentional capture by former targets associated with different amounts of reward (e.g., Anderson and Halpern, 2017) or always presenting reward-predictive stimuli as task-irrelevant distractors (e.g., Le Pelley et al., 2015), the influence of reward can be separated from the influence of status as a former target.

One of the hallmarks of value-driven attention is that it can be observed using stimuli that are no more physically salient than other non-targets and less salient than the target (Anderson et al., 2011b). Similar observations have been made for aversively-conditioned stimuli (Schmidt et al., 2015a), former-target-colored stimuli (Sha and Jiang,

2016), and novel stimuli (Johnston et al., 1990, 1993), and priming has long been noted to occur for non-salient stimuli that repeat (Geyer et al., 2006; Kristjansson et al., 2002; Wang et al., 2005). With the exception of novel stimuli, whose priority derives from their relative absence of prior exposure, the learning that gives rise to selection history effects on attention has frequently been linked to non-salient stimuli. For example, reward-associated targets are typically one of multiple stimuli in a multicolored array in the classical value-driven attentional capture paradigm (Anderson et al., 2011b), with similar training phases having been used to demonstrate attentional biases toward former targets (Sha and Jiang, 2016). Contextual cueing (Chun and Jiang, 1998, 2003) and high-probability target location (Jiang et al., 2013b, 2015a; Jiang and Swallow, 2013) effects are typically observed using arrays that do not contain physically salient stimuli.

It is interesting to note that, almost exclusively, the influence of selection history on attention has been observed for previously task-relevant (e.g., Anderson et al., 2011a, b; Anderson and Halpern, 2017; Anderson and Yantis, 2012; Chun and Jiang, 1998, 2003; Jiang et al., 2013b; Kyllingsbaek et al., 2001; Sha and Jiang, 2016; Theeuwes and Belopolsky, 2012) or physically salient stimuli (e.g., Anderson and Britton, 2020; Anderson et al., 2011a; Bucker and Theeuwes, 2017; Horstmann, 2002; Kim and Anderson, 2021a; Le Pelley et al., 2015; Neo and Chua, 2006; Vatterott and Vecera, 2012; Wang and Theeuwes, 2018a, b, c), or participants are informed of the relationship between certain stimuli and valent task outcomes, thereby highlighting the information value of such stimuli (e.g., Bucker et al., 2015a, b; Failing et al., 2015; Pearson et al., 2020). This is perhaps unsurprising if one approaches the learning that underlies selection history effects on attention from the perspective of biased competition; if attention is not directed to a stimulus, it will not be distinguished from other, competing stimuli in the visual system (Desimone and Duncan, 1995; Reynolds et al., 1999; Serences and Yantis, 2006). Under such circumstances, it is difficult to imagine how stimulus-specific learning could occur for a stimulus that is not either already attended (either by virtue of its task-relevance or physical salience) or presented in isolation without other stimuli to compete with it (as in, e.g., Pool et al., 2014; Schmidt et al., 2015a). This conclusion is consistent with the findings of Failing and Theeuwes (2017), who showed that value-driven attentional capture only occurs when the valuable stimulus is initially prioritized for selection. In this sense, goal-directed and stimulus-driven attention may to a large extent gate the sensory input that selection history can shape attention to through learning (see also Gong and Liu, 2018), reflecting an intrinsic interdependence among mechanisms of attentional control. A natural prediction that arises from the dependence of selection history on the resolution of biased competition during learning is that experience-driven orienting should be able to shape the course of further influences of selection history, with selection history gating the teaching signals applied unto itself. At least one source of evidence for this idea can be found in the fact that value-driven attentional capture is modulated by subsequent rewards that are in fact unrelated to previously reward-associated distractors, as if previously reward-associated distractors continue to be linked to current reward by virtue of their being attended and their priority updates accordingly (Anderson et al., 2013b).

2.3. In what ways is attention shaped by selection history?

Selection history shapes the control of attention by both facilitating the selection of some stimuli as well as facilitating the ignoring of others, both up-weighting and down-weighting attentional priority. Previously reward-associated (Anderson et al., 2011b; Anderson and Yantis, 2012) and threat-associated stimuli (Anderson and Britton, 2020; Schmidt et al., 2015a) capture attention as task-irrelevant distractors, as do novel/infrequent stimuli (Folk and Remington, 2015; Neo and Chua, 2006; Retell et al., 2015) and former-target-colored stimuli (Sha and Jiang, 2016; see also Kyllingsbaek et al., 2001; Qu et al., 2017).

Contextual cueing (Chun and Jiang, 1998, 2003) and target location probability effects (Jiang et al., 2013b, 2015a; Jiang and Swallow, 2013) involve biasing attention toward the likely target location. At the same time, frequent distractor locations come to be suppressed, with distractors resulting in reduced interference when appearing at a high-probability location (Leber et al., 2016; Wang and Theeuwes, 2018a, b, c); although it is possible that such effects reflect strategic attentional control, as will be discussed in more detail in Section 2.6, the fact that such biases are evident with minimal awareness of the distractor–location probabilities suggests a more direct influence of learning from past experience (e.g., Failing et al., 2019a, b; Jiang et al., 2013a, b, 2015a; Wang and Theeuwes, 2018a). Similarly, exposure to a distractor presented in a frequent color will result in improved ignoring of that color distractor, but such improved ignoring will not generalize to newly-encountered color distractors, suggesting learned, feature-specific suppression (Stilwell et al., 2019; Vatterott and Vecera, 2012). Inter-trial priming involves both facilitated selection of a repeated target feature and facilitated ignoring of a repeated distractor feature (Kristjansson and Driver, 2008; Lamy et al., 2008; Maljkovic and Nakayama, 1996). There is some evidence that individuals can learn to more efficiently ignore learned reward cues and threat cues in an enduring way when such selective ignoring is sufficiently beneficial to trial outcomes (Grégoire et al., 2021a), which will be discussed in more detail later, and that former-target-color stimuli can be selectively suppressed on a subset of trials (Anderson and Kim, 2020).

Concerning the increased attentional priority of stimuli attributable to selection history, this elevated priority is reflected in both more frequent initial orienting as well as slower disengagement. Reward cues (e.g., Anderson and Kim, 2018a, b, 2019a, b; Anderson et al., 2020; Anderson and Yantis, 2012; Pearson et al., 2016; Theeuwes and Belopolsky, 2012), threat cues (e.g., Anderson and Britton, 2020; Mulckhuyse et al., 2013; Mulckhuyse and Dalmaijer, 2016; Nissens et al., 2017; Schmidt et al., 2015b), and former-target-color stimuli (e.g., Anderson and Kim, 2020; Grubb and Li, 2018) all draw initial eye movements more than similarly physically salient and task-irrelevant non-targets. Novel stimuli are more likely to draw early saccades; the effect of these stimuli is not always evident until the second saccade, although novelty-driven orienting is often studied using more difficult visual search tasks that may be less conducive to initial capture (Horstmann and Ansorge, 2006, 2016; Horstmann and Herwig, 2016; Horstmann, 2002). In contextual cueing, the first eye movement is biased toward the target location associated with a distractor configuration or configuration of objects within a scene (e.g., Brockmole and Henderson, 2006a; Peterson and Kramer, 2001; Ramey et al., 2019), and the same is true of the region of a display in which targets frequently appear (e.g., Jiang et al., 2014; Jones and Kaschak, 2012; Salovich et al., 2018). When used as uninformative spatial cues, stimuli previously associated with reward (e.g., Bourgeois et al., 2016, 2017; Failing and Theeuwes, 2014; Pool et al., 2014) and threat (e.g., Koster et al., 2004a; Schmidt et al., 2017; Van Damme et al., 2008) have been shown to produce a significant cue validity effect, also consistent with a bias in initial orienting. When used as uninformative cues, there is generally little incentive not to attend to previously reward- or threat-associated stimuli, making it somewhat ambiguous whether lingering effects of goal-directed attentional biases contribute to performance, although there is no explicit incentive for participants to persist in prioritizing such stimuli.

Although most investigations of experience-driven attention have not explicitly assessed disengagement costs, previously reward-associated stimuli were shown to be associated with prolonged disengagement in a task designed to measure this phenomenon (Watson et al., 2020; see also Muller et al., 2016). Threat cues are well established to hold attention longer than neutral stimuli (e.g., Koster et al., 2004a, 2004b). Novel distractors are similarly fixated longer than familiar distractors (e.g., Ernst et al., 2020; Horstmann and Herwig, 2016).

A similar question can be posed concerning the role of selection history in facilitating ignoring: Does such facilitated ignoring involve inhibition of distractors, speeded rejection of distractors once selected (faster disengagement of attention), or both? Distractors appearing at high-probability distractor locations are both fixated less frequently and, when fixated, for a shorter duration compared to distractors appearing at lower-probability locations (Wang et al., 2019a). Evidence from pretrial electroencephalography (EEG) reveals elevated inhibitory processing (indexed by alpha power) at the high-probability distractor location even before stimuli appear (Wang et al., 2019b). In contextual cueing, not only is selection of the target facilitated, but non-targets are also fixated less frequently in familiar configurations (e.g., Harris and Remington, 2017; Liechty and Madhavan, 2011; Peterson and Kramer, 2001) and scan paths are more efficient (e.g., Ramey et al., 2019).

Interestingly, it appears that selection of previously reward-associated stimuli is particularly resistant to inhibitory processes, suggesting an opposing relationship between reward learning and stimulus suppression. For example, when attention is spatially focused, physically salient stimuli can be effectively ignored (Yantis and Johnston, 1990), although previously reward-associated distractors continue to capture attention (Munneke et al., 2015, 2016; see also MacLean et al., 2016). Under task conditions in which physically salient color singletons are suppressed (Gaspelin et al., 2015, 2017; Gaspelin and Luck, 2018), previously reward-associated distractors still capture attention (Pearson et al., 2020). There is also evidence that previously reward-associated distractors "break through" center-surround inhibition (Wang et al., 2014, 2015a, b). Collectively, this evidence suggests that value-driven attentional priority is quite robust to both goal-directed and stimulus-driven influences on stimulus suppression; however, suppression of high-value stimuli is possible especially when participants are given advance warning about the presence of a high-value distractor (Gong and Li, 2016) and under certain conditions in which the high-value distractor can be identified on this basis of its high physical salience (Gong et al., 2017) or participants must efficiently ignore the stimulus in order to obtain reward (Grégoire et al., 2021a).

Also worth mentioning in this section is evidence that selection history can shape feature tuning or the sharpening of stimulus representation. Perceptual learning, a process by which participants can learn to accurately make more precise feature discriminations within a highly-practiced region of feature space, is in many cases the result of history as a sought target (e.g., Ahissar and Hochstein, 1993; Gilbert et al., 2001; Schoups et al., 2001; Shiu and Pashler, 1992). Perceptual learning can occur for task-irrelevant stimuli as well, known as task-irrelevant perceptual learning, but is thought to be gated by learning signals from task processing or reward (e.g., Pascucci et al., 2015; Roelfsema et al., 2010; Sasaki et al., 2010; Seitz et al., 2005; Seitz and Watanabe, 2005), ultimately tying it back to selection history. More generally, there is evidence that pairing a stimulus with reward enhances perceptual learning tied to that stimulus (Serences and Saproo, 2010), and that reward sharpens the representation of associated stimulus features even if those features are processed subliminally when reward is received (Seitz et al., 2009).

2.4. What becomes prioritized with selection history?

Many prior studies investigating the effects of reward history (e.g., Anderson et al., 2011b; Laurent et al., 2015) and aversive conditioning (e.g., Anderson and Britton, 2020; Schmidt et al., 2015a, b) on attention have associated these outcomes with elementary visual features and then present stimuli that vary along the corresponding feature dimension, thereby isolating the influence of the outcome-predictive feature on the control of attention. Most prior studies have used color as the outcome-predictive feature (e.g., Anderson et al., 2011a, b; Kim & Anderson, 2019a, ; Le Pelley et al., 2015) given its rich history in attentional control research (e.g., Folk et al., 1992; Wolfe et al., 1989), although orientation (Laurent et al., 2015; Lee and Shomstein, 2014; Theeuwes and Belopolsky, 2012) and basic shape (e.g., Della Libera and

Chelazzi, 2009; Della Libera et al., 2011) have also been employed. The precision with which valent outcomes are associated with a particular feature is apparently somewhat limited, with value-based attentional priority extending to stimuli possessing a feature similar to that previously associated with reward (Anderson, 2017c). For example, when red is predictive of reward during training, orange stimuli will to a significant degree capture attention in a subsequent test phase (Anderson, 2017c). A similar degree of imprecision has been demonstrated for goal-contingent attentional capture (Anderson, 2014; Anderson and Folk, 2010) and may reflect a fundamental limitation in the precision with which stimuli are represented in the visual system, with similar features activating overlapping populations of visually-responsive neurons (e.g., Hubel and Wiesel, 1962; Johnson et al., 2008).

Other studies, however, have associated valent outcomes with more complex objects (e.g., Barbaro et al., 2017; Donohue et al., 2016; Hickey and Peelen, 2015; Hickey et al., 2015; Le Pelley et al., 2017) and even scene semantics (Failing and Theeuwes, 2015) and have shown similar results. Interestingly, studies of the neural correlates of value-driven attention (Anderson et al., 2014a; Anderson, 2017d; Hickey and Peelen, 2015; Kim and Anderson, 2020a, b) and aversively-conditioned attention (Kim et al., 2021c) using color-defined stimuli have repeatedly shown elevated distractor-evoked activity in lateral occipital cortex, which is associated with object-selective processing (Cichy et al., 2011; Grill-Spector, 2010; Malach et al., 1995), rather than earlier visual areas such as V1 and V4 (e.g., Johnson et al., 2008; Wade et al., 2008) associated with lower-level color-selective representation (although see Itthipuripat et al., 2019; Serences, 2008). This raises the interesting possibility that object identity plays an integral role in attentional orienting to valent stimuli, consistent with the value-dependent modulation of object-selective neurons in the caudate tail (Kim and Hikosaka, 2013; Yamamoto et al., 2013, 2012) and its connections with the visual and oculomotor systems (Giggs et al., 2017; Seger, 2013). Inter-trial priming (e.g., Geyer et al., 2006; Kristjansson et al., 2002; Wang et al., 2005), novelty (e.g., Johnston et al., 1990, 1993; Johnston and Schwarting, 1997), learned statistical dependencies among objects (e.g., Yu and Zhao, 2015; Zhao et al., 2013), and target history effects (Kyllingsbaek et al., 2001; Qu et al., 2017) have also been observed at the level of complex shapes and objects defined by a conjunction of features.

At the same time, spatial attention has been robustly linked to selection history effects on attention. This includes both biases toward locations at which targets frequently appear (e.g., Geng and Behrmann, 2002, 2005; Jiang, 2018; Jiang et al., 2013b, 2015a; Jiang and Swallow, 2013; Stankevich and Geng, 2014) and suppression of locations at which distractors frequently appear (e.g., Failing et al., 2019a, b; Wang and Theeuwes, 2018a, b, c). Such biases have been observed for multiple locations in accordance with task contingencies (e.g., Britton and Anderson, 2020; Failing et al., 2019a), suggesting a flexible shaping of priority not limited in capacity to a single contiguous region, consistent with evidence for the splitting of spatial attention (e.g., Awh and Pashler, 2000; Jefferies et al., 2014). Contextual cueing, which is by definition spatial, has been shown using a variety of context stimuli from those varying in elementary features such as orientation (e.g., Chun and Jiang, 1998, 2003) to more complex objects (e.g., van Asselen et al., 2011; Chun and Jiang, 1999) to the arrangement of objects in a real-world scene (Brockmole and Henderson, 2006a, b; Brockmole et al., 2006; Brooks et al., 2010). The ability of reward history to shape spatial attention is more controversial (Bourgeois et al., 2018a; Chelazzi et al., 2014; Jiang et al., 2015a; Won and Leber, 2016) and may rely on explicit knowledge of reward contingencies and the ability of reward to reinforce goal-directed orienting (Anderson and Kim, 2018a, b). A direct influence of reward learning (Liao and Anderson, 2020b; McCoy & Theeuwes, 2018) and punishment learning (Anderson, 2021b) on directional eye movements has also been observed, which may reflect reinforcement learning tied to the orienting response; such learning-dependent orienting is often not explicitly inconsistent with task goals, raising the possibility of a lingering effect of strategic

attentional control, although as with uninformative spatial cues there is no incentive to maintain use of any such strategy and such biases can be evident without any awareness of the outcome contingencies (Anderson, 2021b). Inter-trial priming has been robustly linked to orienting to particular spatial locations (Geyer et al., 2007; Maljkovic and Nakayama, 1996; Talcott and Gaspelin, 2020) and spatial priming is modulated by trial-by-trial rewards (Hickey et al., 2014).

Work on target history effects suggests that, in addition to prioritizing features that frequently define a sought target (e.g., Qu et al., 2017; Sha and Jiang, 2016), individuals can learn to engage something akin to a filtering function applied to display-wide visual input. Specifically, participants can learn to prioritize either a particular feature or physically salient signals within the display (feature search mode or singleton detection mode), depending on how diagnostic physical salience is of target identity (Cosman and Vecera, 2013; Leber and Egeth, 2006a, b; Leber et al., 2009). That is, given the relationship among targets and non-targets, participants learn *how* to prioritize the incoming visual signals and continue to apply this mode of prioritization even when the nature of the stimulus displays changes and it is no longer as efficient (Cosman and Vecera, 2013; Leber and Egeth, 2006a, b; Leber et al., 2009). Such findings could reflect a residual effect of goal-directed attention, although the fact that these biases are evident even when they facilitate distraction is consistent with a more involuntary influence of selection history. Recent evidence suggests that search for a feature-defined target may similarly involve learning to apply a display-wide filtering function, with participants learning to orient on this basis of relative color (e.g., "redder than" competing stimuli) rather than to an absolute feature value (e.g., the color orange, which defines the target; Liao et al., 2020a), consistent with how goal-directed attention is directed under the same conditions used during training (Becker, 2010; Becker et al., 2010, 2013). Such evidence is at odds with an account of target history effects implicating an upweighting of feature-specific responses in early visual areas as might be predicted from a perceptual learning mechanism (e.g., Roelfsema et al., 2010; Seitz et al., 2009; Serences and Saproo, 2010). Given that inter-trial priming reflects both a bias in favor of target-defining features and a bias against distractor-defining features on the prior trial (Kristjansson and Driver, 2008; Lamy et al., 2008; Maljkovic and Nakayama, 1996), a similar sort of mechanism might be at play here as well.

Although most extensively studied in the context of vision, there is substantial evidence that the influence of selection history on the control of attention reflects a broader principle that extends to the role of attention in other sensory modalities. Previously reward-associated sounds are prioritized in the auditory system, leading to increased auditory distraction (Anderson, 2016c; Asutay and Vastfjall, 2016; Kim et al., 2021a; see also Cheng et al., 2020; Sanz et al., 2018), as is the case following aversive conditioning (Staib and Bach, 2018; Staib et al., 2020). Statistical learning has a rich history in the auditory domain, which is thought to be mediated by attention to predictable sequences of sounds (e.g., Addleman and Jiang, 2019a; Rimmele et al., 2011; Shen and Alain, 2012; Zimmermann et al., 2017). Contextual cueing can be observed for auditory stimuli (Doan, 2014), as can biases related to the frequency of targets by location (Addleman and Jiang, 2019a, b) and novel sounds ("oddballs") capture attention (e.g., Alho et al., 1997; Debener et al., 2002; Parmentier et al., 2008). The affective potency of an olfactory stimulus has been linked to attentional capture by the stimulus (Grabenhorst et al., 2011).

So far, we have discussed the nature of the perceptual input that becomes prioritized through selection history. A final consideration with respect to the nature of what becomes prioritized concerns how contextual dependencies affect priority. In this respect, there are interesting differences across different components of experience-driven attention. The attentional priority of reward-predictive stimuli will generalize to novel contexts when no context manipulation is used during reward training (Anderson et al., 2012; Mine and Saiki, 2015, 2018), suggesting a bias to apply prior learning to new contexts and

situations. Similarly, when reward (Carsten et al., 2019; Krebs et al., 2010, 2011; Liao et al., 2020b) or an aversive outcome (Liao et al., 2020b) is associated with one stimulus dimension (color), the attentional bias for this dimension will extend to a different but related stimulus dimension (the word for the high-priority color), and attentional biases for previously reward-associated (Grégoire and Anderson, 2019) and aversively-conditioned words (Grégoire et al., 2021b) can generalize to semantically-related words. However, with respect to both reward learning (Anderson, 2015a, b) and aversive conditioning (Grégoire et al., 2021c), when context carries outcome-relevant information, such that certain stimuli are only associated with a valent outcome in a particular context, attentional capture by such stimuli will be context-specific. Contextual cueing can be modulated by scene context (Brockmole et al., 2006; Brockmole and Henderson, 2006a, b; Brooks et al., 2010), and individuals can learn to engage a particular search mode in context-specific fashion (Cosman and Vecera, 2013). Similar to contextual cueing, the influence of reward on spatial attention can be scene-specific, with different locations being prioritized in different scenes (Anderson and Kim, 2018a, b), potentially reflecting a role for reward in shaping the scene-specific behavior that ultimately becomes habitual.

On the other hand, selection of a frequent target feature (Anderson and Britton, 2019) and inhibition of a frequent distractor location (Britton and Anderson, 2020) appear not to be context-specific. Specifically, if targets are only ever red when appearing against one background scene and only ever green when appearing against another background scene, participants will exhibit a bias to select both colors in a manner that does not discriminate between contexts (Anderson and Britton, 2019). The same is true for two different high-probability distractor locations that vary with context (Britton and Anderson, 2020). Also in contrast to the manner in which reward learning and aversive conditioning influences attention, attentional biases for frequent target locations are more narrow in the contexts to which they generalize (Jiang et al., 2015b; Salovich et al., 2018). These differences in the role of context in modulating selection history effects could reflect a fundamental distinction between different mechanisms of selection history that we will return to later in the manuscript.

2.5. At what stage of information processing does selection history influence attention?

There are several sources of evidence suggesting that selection history can influence information processing early in the perceptual system, particularly when it comes to the generation of eye movements. Research described in the previous section highlight multiple cases in which reward learning and aversive conditioning bias initial eye movements (e.g., Anderson and Kim, 2019a, b; Anderson and Yantis, 2012; Pearson et al., 2016; Theeuwes and Belopolsky, 2012). Such an influence is evident early in the process of saccade generation, with even the fastest saccades being biased toward valent stimuli (e.g., Bucker et al., 2015a,b; Mulckhuyse et al., 2013; Pearson et al., 2016; Schmidt et al., 2017). At the same time, the influence of reward learning and aversive conditioning is not restricted to rapid initial orienting, also being evident for slower-to-generate saccades (e.g., Bucker et al., 2015a, b; Mulckhuyse and Dalmaijer, 2016; Pearson et al., 2016; Schmidt et al., 2017) and, as described above, can also influence the disengagement of attention (Watson et al., 2020; Koster et al., 2004a, 2004b; Muller et al., 2016). Contextual cueing effects can be observed with only very brief exposure to the stimulus array (Chun and Jiang, 1998; Kobayashi and Ogawa, 2020). Effects of novelty can be evident in spatial cuing paradigms with a brief (e.g., 150 ms) stimulus-onset-asynchrony between the cue and target display (Folk and Remington, 2015), as can a bias to orient toward more frequent target-defining features (Cosman and Vecera, 2014), consistent with early influences.

At the same time, it appears that selection history is not tantamount to an increase in the physical salience of an object in early stages of perception. This issue has been the most extensively studied in the context of reward history, perhaps as a result of initial suggestions that reward modulates object salience (e.g., Hickey et al., 2010a; Hickey and van Zoest, 2012). Reward history does not affect the speed with which an object is perceived to have appeared, in contrast to the influence of physical salience (Rajsic et al., 2017). Electroencephalography (EEG) recordings of stimulus processing further support this notion, with value associations influencing the strength but not the speed of orienting as measured from the N2pc (Bachman et al., 2020), in contrast to physical salience (Bachman et al., 2020) and goal-directed spatial attention deployed in advance of target presentation (Foster et al., 2020) which do affect speed. Value associations can affect estimates of numerosity, biasing perception in favor of previously reward-associated stimuli, but only when displays are not masked, suggesting no measurable bias in initial perception (Dodgson and Raymond, 2020). Neither reward- nor loss-associated stimuli bias figure-ground assignment in favor of valent objects using briefly-presented displays (Onie et al., 2021). It is unclear to what extent these findings apply to other components of experience-driven attention beyond reward history; an exception might be inter-trial priming, which does affect the latency of the N2pc (Eimer et al., 2010). Although influences of reward history (e.g., Itthipuripat et al., 2019; Serences, 2008; van Koningsbruggen et al., 2016; see also MacLean & Giesbrecht, 2015b) and aversive conditioning (Miskovic and Keil, 2012; Stolarova et al., 2006; Thigpen et al., 2017) have been observed as early as visual area V1, as will be contextualized later in the manuscript with respect to neural mechanisms, such observations may reflect feedback from later stages of information processing. Thus, it appears that selection history exerts its influence on information processing at the level of competition for attentional selection rather than amplifying feedforward processes in early stages of perception, with the potential exception of inter-trial priming (Eimer et al., 2010).

At the same time, selection history can exert an influence at qualitatively later stages of information processing, and in particular at the level of semantic representations. For example, attention is biased toward objects that are semantically related to a currently fixated object, even when such semantic information is irrelevant to the task at hand and either no one object is more likely to contain a task-relevant target (and thus there is no motivation to prioritize any one object via goal-directed attention) or the semantically related object is in fact less likely to contain a target (and should thus be to some degree deprioritized by goal-directed mechanisms of attentional control; Malcolm et al., 2016). Visual search for an object is also strongly biased toward regions that are statistically more likely to contain that object based on semantic and syntactic considerations arising from the layout of the scene (e.g., Ohlschlager and Vo, 2020; Vo and Wolfe, 2013; Wolfe and Horowitz, 2017), reflecting memory-based guidance that is learning-dependent. Presumably, these semantic relationships are learned from prior experience, which would implicate selection history (see also Peacock et al., 2019), although such studies do not explicitly manipulate prior experience with stimuli and thus caution is warranted in attributing the effects to selection history per se. It is clear, however, that certain components of experience-driven attention can operate at the level of a semantic representation. In the context of value-based attention, stimuli semantically-related to reward-associated words cause increased interference in a modified Stroop task, suggesting semantic generalization of value-based attentional priority (Grégoire and Anderson, 2019), and a comparable effect has been observed for aversively-conditioned words as well (Grégoire et al., 2021b). Attentional orienting to a novel stimulus can also be observed when the stimulus is novel with respect to meaning (Johnston et al., 1990, 1993; Johnston and Schwarting, 1997), and target-history-related biases can be observed for more complex objects not defined by a single elementary feature (e.g., Kyllingsbaek et al., 2001, 2014; Qu et al., 2017; Shiffrin and Schneider, 1977). Lastly, priming at the level of semantic representations has long been noted to influence attention (Belke et al., 2008; de Groot et al., 2016; Moores et al., 2003; Telling et al., 2010).

As described in Section 2.3, previously reward-associated stimuli appear resistant to inhibitory processes with respect to competition for attentional selection (Pearson et al., 2020; Munneke et al., 2015, 2016; Wang et al., 2014, 2015a, b). It seems also to be the case that this bias extends to the selection of associated motor responses. When presented in color to which participants are prepared to withhold a motor response ("no-go" color), task-irrelevant distractors elicit a reverse-compatibility effect in a flankers task indicative of the inhibition of their associated response (Anderson and Folk, 2012a, 2014; Anderson et al., 2016a). When the same color is previously associated with high value, however, such inhibition is not observed and under some circumstances even changes to response facilitation (Anderson et al., 2016b; Kim & Anderson, 2019b). Such value-based modulation of stimulus-evoked response biases is reflected in activity within the motor cortex of the brain (Kim and Anderson, 2019b), providing further and more direct evidence that learned reward associations influence the motor activity evoked by stimuli. Value-driven attentional biases are particularly pronounced for stimuli to which approach actions were required to obtain reward (Suh and Abrams, 2020). More generally, the presentation of a reward cue is associated with increased motor excitability (Freeman et al., 2014; Freeman & Aron, 2015), although it is less clear what role strategic goal-directed processes play in this case. Collectively, such findings are consistent with an overall relationship between value-driven attention and the facilitation of approach behavior (Anderson, 2017b; see also Moher et al., 2015), and there is suggestive evidence of a tendency toward attentional capture by threat cues eliciting a bias toward avoidance behavior (Carsten et al., 2019; Liao et al., 2020b).

Value-driven attention can also have indirect effects on approach behavior by interfering with the ability to assess the value of other stimuli (Itthipuripat et al., 2015) and facilitating risk-taking, potentially by biasing the perception of available reward (San Martin et al., 2016). Some effects of reward history on the facilitation of behavior can likely be attributed to downstream consequences of prioritizing stimuli in perceptual processing, particularly in cases where stimulus-evoked responses are enhanced. When previously reward-associated stimuli are less effective in generating stimulus-evoked inhibitory responses (Anderson et al., 2016b; Kim and Anderson, 2019b), however, it seems that a bias to process the stimulus-evoked response signal as an approach signal is at play.

2.6. How is selection history learned?

There is substantial evidence that selection history can exert an influence on attention through implicit learning. Contextual cueing has long been thought to be the product of implicit learning, with poor explicit recognition of previously experienced stimulus configurations (e.g., Chun and Jiang, 2003; Colagiuri and Livesey, 2016), although there is some evidence that explicit learning can also occur in contextual cueing paradigms and may play some modulatory role (Smyth and Shanks, 2008; Vadillo et al., 2016). Although attentional biases toward former target-defining features per se are by definition explicit, a stronger bias for more frequent target features appears to be implicit (Cosman and Vecera, 2014; see also Cosman and Vecera, 2013), and participants can develop a persistent attentional bias that reflects the target–non-target relations rather than the feature that participants are tasked with finding (Liao et al., 2020a). Such findings suggest that target history can influence attention via implicit learning mechanisms, and even when participants are explicitly aware of the target they are searching for, such explicit awareness may not play a central role in the learning that ultimately shapes attentional priority via selection history.

Several studies demonstrate that reward learning can bias attention in participants who are unaware of the stimulus-reward associations (e. g., Anderson et al., 2013a; Anderson, 2015a, b; Anderson and Yantis, 2013; Bourgeois et al., 2016; Pearson et al., 2015; Theeuwes and Belopolsky, 2012; see also Seitz et al., 2009; Serences, 2008), including studies performing a rigorous test of awareness in which participants try

to guess how much reward they would receive on different trials (e.g., Grégoire and Anderson, 2019; Grégoire et al., 2021a; Leganes-Fonteneau et al., 2018, 2019). Similar evidence exists for attentional biases for threat-associated stimuli (Hopkins et al., 2016; Grégoire et al., 2021c; see also Grégoire et al., 2021a). Frequent target (e.g., Jiang et al., 2013a, b, 2015a; Jiang and Swallow, 2013; Salovich et al., 2018) and distractor locations (Failing et al., 2019a, b; Leber et al., 2016; Wang et al., 2019a; Wang and Theeuwes, 2018a) have been shown to bias attention in individuals with little awareness of the probability of stimuli appearing at different locations, although questions can be raised concerning the sensitivity of the awareness tests often used in these cases (Vadillo et al., 2020). At the same time, however, there have been some reports that value-driven attentional capture is stronger in participants aware of the reward contingencies (Bourgeois et al., 2017; De Tommaso et al., 2019; see also Tibboel and Liefooghe, 2020), especially in the case of the influence of reward on spatial attention (Anderson and Kim, 2018a, b; Mine et al., 2021; Sisk et al., 2020; see also Liao and Anderson, 2020b), possibly reflecting motivational influences of reward on goal-directed attention and learning. In stark contrast, there are at least a pair of studies demonstrating effects of selection history on attentional bias only in participants unaware of the reward contingencies (Grégoire and Anderson, 2019; Leganes-Fonteneau et al., 2019), painting a more complicated picture of awareness and value-based attention. It even appears that value-driven attention does not itself depend on awareness of the eliciting stimulus (Harris et al., 2016). In summary, selection history appears to influence attention via implicit learning mechanisms, although explicit awareness may play some modulatory role.

Given its central role in the literature on associative reward learning, the role of reward prediction-errors has been a topic of interest in the study of value-driven attention. As discussed at some length in Anderson (2016b), it appears to be the case that cues predicting a comparatively high amount of reward are prioritized by attention and it is not the raw magnitude of reward associated with a stimulus per se that guides attention. Some of the most direct evidence for this comes from a study that showed that simply providing a monetary incentive for finding a target was insufficient to produce value-driven attentional capture if the target color did not resolve uncertainty about the amount of reward that could be expected (Sali et al., 2014). Attentional biases toward learned reward cues continue to be updated by corresponding reward prediction-errors even when they have been made entirely irrelevant to the task (appear as task-irrelevant distractors) and no longer have any systematic relationship with reward outcome (Anderson et al., 2013b). A recent study shows that the relative, rather than absolute, amount of reward predicted by a stimulus determines the magnitude of subsequent attentional bias (Kim and Beck, 2020), as would be predicted from prediction-error accounts. Correspondingly, activity within regions of the brain coding reward prediction-errors have been related to the value-based control of attention (Arsenault et al., 2013; Barbaro et al., 2017; Hickey and Peelen, 2015, 2017; Meffert et al., 2018; see Anderson, 2019, for a review). Attention is sensitive to the frequency of novel stimuli (Folk and Remington, 2015; Neo and Chua, 2006) and the predictiveness of the configuration of non-targets in contextual cueing (Brady and Chun, 2007; Brockmole et al., 2006; Brooks et al., 2010; Higuchi et al., 2020; Jiang and Wagner, 2004; Olson and Chun, 2002; Zinchenko et al., 2018), and the frequency of distractors appearing at a high-probability location exert graded effects on attention (Lin et al., 2021); along with the target frequency effects described above (e.g., Cosman and Vecera, 2014; e.g., Jiang et al., 2013a, b, 2015a; Jiang and Swallow, 2013), such evidence suggests that learning from the predictiveness of stimulus–stimulus and stimulus–outcome relationships may play a key role in the influence of selection history on attention.

Attention is generally biased towards the most valuable or threatening stimulus, (De Tommaso et al., 2019; Koenig et al., 2017a, b; Le Pelley et al., 2019a), although with value equated, there is some evidence that attention is more biased toward stimuli associated with a more uncertain outcome in both initial orienting (Le Pelley et al., 2019a)

and dwell time (Koenig et al., 2017a; see also Koenig et al., 2017b). At the same time, information-seeking biases are evident in which attention prioritizes stimuli that reduce uncertainty about which future action needs to be taken (Foley et al., 2017; Horan et al., 2019), the magnitude of reward available (Bromberg-Martin and Hikosaka, 2009), or whether reward will be delivered when the outcome cannot be controlled (Daddaoua et al., 2016), which appear to be distinctly coded from the value signals that guide attention (Bromberg-Martin and Hikosaka, 2009; Foley et al., 2017; Horan et al., 2019); this is consistent with an attentional bias driven by curiosity, to which an attentional bias to novel stimuli may be related (Gottlieb et al., 2016), although the role of goal-directed attentional processes in mediating these phenomena is less clear. Even when there is no explicit outcome, predictable sequences of stimuli are preferentially attended (Yu and Zhao, 2015; Zhao et al., 2013; Zhao and Luo, 2017), suggesting that attentional priorities constantly track the frequency of outcomes linked to different stimuli (including stimulus-stimulus relationships). There may be a distinction between attentional biases geared toward exploration versus exploitation depending on how much is known about outcome contingencies (Gottlieb and Oudeyer, 2018; Le Pelley et al., 2019a), which is an issue we will return to later in the paper.

Concerning the outcomes that modulate attention via selection history, a variety of rewards have been shown to influence attention. This includes monetary reward (e.g., Anderson et al., 2011b; Anderson and Halpern, 2017; Della Libera and Chelazzi, 2009), social reward (Anderson, 2016a; Anderson and Kim, 2018c; Kim and Anderson, 2020b; Hayward et al., 2018), and liquid reward (De Tommaso et al., 2017; see also Seitz et al., 2009). With respect to aversive conditioning, a similar variety is evident, with attention being shaped by electric shock (e.g., Anderson and Britton, 2020; Nissens et al., 2017; Schmidt et al., 2015a, b; Wang et al., 2013), monetary loss (e.g., Le Pelley et al., 2019b; Wang et al., 2013; Wentura et al., 2014), negative social feedback (Anderson, 2017a; Anderson and Kim, 2018c), and aversive sounds (e. g., Koster et al., 2004a; Smith et al., 2006; Van Damme et al., 2008). Monetary loss presents an interesting case, as it could promote learning from aversive conditioning as well as learning from negative reinforcement particularly in cases where losses can be minimized through rapid and accurate target identification (Carsten et al., 2019; Le Pelley et al., 2019b; Wang et al., 2013; Wentura et al., 2014) or the choices participants make in a decision-making task (e.g., Raymond and O'Brien, 2009; Rutherford et al., 2010). Unavoidable loss appears to be less robust in biasing attention (Becker et al., 2020; see also Barbaro et al., 2017; Raymond and O'Brien, 2009; Rutherford et al., 2010), suggesting that negative reinforcement learning may play the more dominant role in biasing attention to loss-related stimuli. In this respect, the mechanisms underlying the effects of monetary loss on attention may differ from the mechanisms underlying the effects of the other aforementioned aversive outcomes, being more appropriately likened to reward-related effects. Using electric shock and an antisaccade task, one study pitted attentional biases driven by aversive conditioning (orient to a signal for threat) against attentional biases driven by negative reinforcement (quickly look away from the stimulus in order to minimize the prospect of shock) and found that in this case, aversive conditioning had the stronger influence on attention (Kim & Anderson, 2021a). This does not rule out a role for negative reinforcement in the control of attention, but it does suggest that aversive conditioning plays a more dominant role. A similar result was observed using monetary reward in an anti-saccade task (Kim & Anderson, 2019a), further consistent with the aforementioned findings concerning reward prediction-errors and arguing that associative rather than reinforcement learning plays the more dominant role in value-driven attention to reward-predictive stimulus features. Collectively, these studies are broadly consistent with an attentional bias toward predictive cues for a valent outcome.

2.7. How enduring is the influence of selection history on attention?

One of the hallmarks of experience-driven effects on attention is that they persist well after they are no longer supported by task contingencies, suggesting an enduring change in attentional priority that is not a transient consequence of current expectations. For example, reward history can continue to affect attention well into a period of extinction in which rewards are no longer available in the task (e.g., Anderson et al., 2011b, 2014a; Anderson and Yantis, 2012; Stankevich and Geng, 2015) and over half a year after reward learning has taken place (Anderson and Yantis, 2013). A previously high-value stimulus can persist in its ability to capture attention even after a new reward structure is learned in which the stimulus is no longer rewarded, outcompeting a more recently valued stimulus for selection, suggesting a dominant influence of already-established value-based attentional priorities (Liao and Anderson, 2020a). Persistent biases have also been observed following aversive conditioning (e.g., Kim and Anderson, 2021a; Schmidt et al., 2015a) and with respect to contextual cueing (e.g., Chun and Jiang, 2003), biased probabilities concerning target location (e.g., Jiang et al., 2013b) and distractor location (Britton and Anderson, 2020), a change in the target-defining feature (e.g., Anderson and Britton, 2019; Sha and Jiang, 2016) or which target feature is more frequent (Cosman and Vecera, 2014), and the relationship between targets and non-targets (which promotes a particular search mode; Leber and Egeth, 2006a, b; Leber et al., 2009). Value-driven attention can persist even after the reward previously associated with a stimulus has been devalued (De Tommaso et al., 2017), consistent with an enduring change in attentional priority following learning that is not contingent upon current needs. In the case of reward, neurons in the caudate tail have been identified that code stable object value and guide eye movements, consistent with an influence of representations that update over long timescales (Kim and Hikosaka, 2013; Yamamoto et al., 2013, 2012; see also Anderson et al., 2014a; Anderson, 2017d; Kim and Anderson, 2020b). Although eventual extinction of these attentional biases has been noted (e.g., Anderson et al., 2011a, 2016d), the sluggishness with which they apparently update is striking.

2.8. In what ways is the influence of selection history on attention adaptive?

For cases such as contextual cueing (e.g., Chun and Jiang, 1998, 2003; Jiang and Wagner, 2004), target and distractor probability effects (e.g., Geng and Behrmann, 2002, 2005; Jiang, 2018; Jiang et al., 2013b, 2015a; Jiang and Swallow, 2013; Wang and Theeuwes, 2018a, b, c), and other experience-dependent attentional phenomena that leverage the probability or frequency of particular stimuli and attentional demands, the adaptive nature of these phenomena is straightforward because they objectively improve performance in the task in which they are measured. Although such attentional biases typically persist after the contingencies that drive them are no longer in place (e.g., Britton and Anderson, 2020; Jiang et al., 2013b), it would be expected that a change in such biases would require the accumulation of evidence to the contrary given their reliance on implicit learning (e.g., Chun and Jiang, 2003; Colagiuri and Livesey, 2016), and a sluggish ability to update may simply reflect the cost of leveraging the powerful ability to capitalize on them without conscious awareness or effort. Indeed, contextual cuing is subject to substantial primacy effects: it emerges when initially-experienced stimulus displays are structured and persists through when they become unstructured, but does not emerge when displays are initially unstructured and only later become structured, suggesting that contextual cuing reflects the persistence of an initially-adaptive attentional bias rather than a mere reflection of cumulative experience (Jungé et al., 2007). Inter-trial priming should be more often beneficial than costly provided that a repetition of a situation in which a stimulus needs to be selected is more frequently encountered than a situation in which it immediately moves from a selected to a

to-be-ignored stimulus; in a world filled with statistical regularities (see, e.g., Yu and Zhao, 2015; Zhao et al., 2013), this seems like a reasonable assumption.

Findings concerning status as a former target, reward history, and aversive conditioning pose a more intriguing question here, as they are often shown to persist in directing attention to stimuli that are completely task-irrelevant in the current context. That such attentional biases would happen at all has intuitive appeal. In the case of reward-associated and aversively-conditioned stimuli, these stimuli signal events of obvious biological importance, and rapidly and automatically orienting to them both helps to ensure that they will not be ignored or otherwise overlooked and maximizes the speed with which they are detected, thereby maximizing the time that the organism has to plan an appropriate response if one is required. Indeed, the bias toward approach behavior that is accompanied by value-driven attentional capture (Anderson, 2017b; Anderson et al., 2016b; Kim & Anderson, 2019b) and the bias toward avoidance behavior observed for aversively-conditioned stimuli (Carsten et al., 2019; Chen and Bargh, 1999; Elliot and Covington, 2001; Guitart-Masip et al., 2014) fits naturally within this framework. There is some evidence that value-driven attentional processes can even to some degree overcome unilateral spatial neglect (Bourgeois et al., 2018b; Malhotra et al., 2013), offering compelling evidence for the role that value-driven attention can play in ensuring that rewarding opportunities are not missed. This position has been argued from early in the course of research on value-driven attention and is thought to reflect the phylogenetic origins of such attentional bias (Anderson, 2013). In the case of target history effects (e.g., Kyllingsbaek et al., 2001; Qu et al., 2017; Sha and Jiang, 2016; Shiffrin and Schneider, 1977), a similar argument can be made to those outlined in the preceding paragraph–provided that visual environments and task demands remain more stable than variable, the development of habitual or otherwise automatic orienting responses has advantages. But such a position still falls short of addressing the question of why these biases are so strong as to robustly persist when the eliciting stimulus is consistently task-irrelevant in the current context, which is something that has largely been overlooked in theoretical discussions concerning selection history. Is an attentional control mechanism really adaptive if it makes someone so prone to distraction? Similar questions can be posed with respect to attentional capture by novel stimuli that only ever appear as task-irrelevant distractors (e.g., Folk and Remington, 2015; Neo and Chua, 2006).

An often-implied response to this question has been to appeal to how the potential benefits to survival compare to the potential costs of distraction. Previously reward-associated stimuli could signal a fleeting opportunity to acquire the resources needed to survive and thrive, whereas stimuli previously associated with aversive outcomes could signal an imminent threat to health and well-being. A surprising (novel) stimulus could pose a significant threat that is better explicitly accounted for than completely ignored, even if it is ultimately rejected as insignificant. In short, the costs of not orienting to such stimuli could be substantial. On the other hand, the cost of such orienting when there is no threat or opportunity may often be limited to a fleeting distraction from the task at hand, which in most cases will merely cause a momentary delay in the completion of a goal-directed behavior without jeopardizing the ability to bring such behavior through to completion. In this sense, the selection history effects on attention in question could still be adaptive from a cost-benefit comparison if assessed over the course of a life history. A related consideration here is that what was valuable or threatening in the past is likely to be valuable or threatening in the future if one again assumes a stable environment with stable contingencies. In this sense, attentional capture experiments that present previous targets and/or cues for rewarding or aversive outcomes as distractors may not be ecologically valid with respect to typical everyday experience (albeit methodologically necessary for demonstrating the involuntary nature of the orienting response), leading to typical results that appear counter-adaptive within the context in which they are studied.

One prediction arising from this cost-benefit framework is that, when the benefit of ignoring and/or the cost of orienting toward a valent cue is high enough, individuals should be able to move from being distracted by previously reward-associated and aversively-conditioned stimuli to actively ignoring or potentially even inhibiting them. A recent study provides evidence in support of this idea (Grégoire et al., 2021a). Participants were less likely to orient to distractors previously associated with reward and punishment, compared to a neutral distractor, when the presence of those valent distractors signaled the potential for reward or the potential to avoid punishment if target responses were very fast and accurate (precluding attentional capture in order to obtain the desired outcome). In this situation, the reward-maximizing strategy would be to prioritize the target regardless of the distractor color, and participants were in fact not even aware of the color–outcome contingencies in this experiment; this makes it unlikely that the observed reduction in attentional capture by reward- and punishment-associated distractors was the product of stronger goal-directed attentional prioritization of the target on the trials on which these distractors were presented. This was in contrast to robust attentional capture, above-and-beyond the same neutral stimulus, observed under otherwise identical experimental conditions in which the time pressure component was removed from the task, similarly in the absence of awareness of the color–outcome contingencies (Grégoire et al., 2021a). Thus, it appears that selection-history-driven attentional capture is typically observed in experimental tasks when the cost of orienting to a distractor is minimal, and that with sufficient cost for such orienting, it is possible to learn to suppress both reward and threat signals. When fixating a reward-predictive distractor results in the omission of reward, attentional capture by this reward-predictive stimulus is attenuated compared to a situation in which fixating it does not result in reward omission, further consistent with the ability to adaptively suppress the influence of reward on attention at least to some degree (Pearson and Le Pelley, 2020). However, a bias to orient to a shock-predictive cue when the act of saccading to it actually (immediately) triggered the shock was observed in a different study (Anderson and Britton, 2020; see also Nissens et al., 2017), which reflects a case of an experience-driven bias incurring a salient cost, although in this case the threat was present and active at the time attentional capture was assessed and could therefore be characterized as more acute. Thus, although a cost-benefit account of selection history effects on attention has some promise, the weighting that would underly the corresponding computation of cost and benefit is not straightforward and likely has a variety of built-in assumptions about the assignment of priority. Also consistent with a cost-benefit account of when and why selection history biases attention, after initial covert attentional capture, participants are able to strategically avoid fixating a threat-associated stimulus in a foraging task when fixating the stimulus is punished, sustaining this avoidance over the entire course of visual search, essentially marking the stimulus as to-be-avoided (Britton & Anderson, 2021). Attentional capture studies focus on the initial orienting response, but as this study underscores, a full understanding of the adaptive nature of selection history effects on attention must also look beyond this stage.

With respect to the issue of adaptation, it is interesting that attentional biases can be observed for both frequent former targets (e.g., Kyllingsbaek et al., 2001; Qu et al., 2017; Sha and Jiang, 2016; Shiffrin and Schneider, 1977) as well as novel stimuli (e.g., Folk and Remington, 2015; Horstmann and Ansorge, 2006, 2016; Horstmann, 2002; Johnston et al., 1990, 1993; Neo and Chua, 2006), which reflect opposite ends of the explore versus exploit framework (Hills et al., 2015). It appears that the attention system is wired to support each of these demands through a dedicated mechanism that does not require voluntary attentional control. The cost-benefit framework for the phylogenetic origins of experience-driven attentional biases predicts that organisms should be differently biased toward attentional priorities favoring exploration or exploitation depending on which one the task contingencies favor,

although we are unaware of any attentional capture experiments that have addressed this possibility explicitly. Of potential relevance here, one atypical exception to attentional biases toward former target-defining features came in an experiment in which a training phase involving visual search for color-defined targets was followed by a flankers task with color flankers (Anderson et al., 2012; see also Lin et al., 2016). Under such experiment conditions, not only was attention not biased toward flankers rendered in colors previously used to define the target, but it was more so biased toward flankers rendered in a color not used to previously define targets, which the authors interpreted as a bias toward novel stimuli (Anderson et al., 2012). One potential interpretation of this finding is that the change in task biased participants away from an attentional state tuned to exploiting learned contingencies and more towards an attentional state of exploration, which would be consistent with this framework.

2.9. Can the influence of selection history on attention become maladaptive?

Although generally adaptive as a mechanism, as argued in the preceding section, selection history-related influences on attention may become maladaptive when they are contextually inappropriate or inappropriate in degree. On the one hand, too strong an influence of selection history on the control of attention could be detrimental if it facilitates attention to stimuli that the organism later learns are no longer beneficial or even harmful, while on the other hand, an insufficient influence of selection history on attention could lead to inefficient selection and ignored opportunities. There is some evidence that abnormal influences of selection history on attention are related to psychopathological disturbance.

Anderson (2021a, reviews the link between abnormal value-driven attention and psychopathology. Briefly, hypersensitive value-driven attention is linked to drug addiction (Albertella et al., 2017, 2019a, b; Anderson, 2016d; Anderson et al., 2013a, 2016c), impulsive high-risk behaviors, (Anderson et al., 2016c) and compulsivity (Albertella et al., 2019a, 2020), while hyposensitive value-driven attention is linked to depression (Anderson et al., 2014b, 2017a) and difficulty maintaining focus on long-term value characteristic of attention-deficit hyperactivity disorder (Sali et al., 2018). Hypersensitive attention to threat cues is associated with anxiety-spectrum disorders (Mogg and Bradley, 2005), whereas hyposensitive attention to threat cues is associated with psychopathy (Baskin-Sommers et al., 2011, 2012; Newman et al., 2010). Such evidence suggests that, when it comes to the role of valent outcomes in selection history, there is a "sweet spot" within which the influence of selection history is optimal, deviations from which in either direction can have undesirable consequences.

Outside of the role of reward and aversive conditioning in selection history, it is less clear whether too strong of an influence would be in-and-of-itself problematic. More likely is the possibility that abnormally strong biases in these areas could facilitate behavioral rigidity, and in a context in which they are no longer beneficial in facilitating attention to an important stimulus, interfere with an individual's ability to adapt to a change in the environment (e.g., the consequences of rearranging a room or moving to a new office on the ability to find things). Such may be the consequences of an attention system that efficiently learns from environmental regularities. Given the ways in which selection history is broadly adaptive, as described in the preceding section, it is not difficult to imagine how a blunted influence of each component of experience-driven attention could be detrimental. For example, contextual cueing is typically impaired with amnesia (Chun and Phelps, 1999; Park et al., 2004; see also Negash et al., 2007), which may be related to the broader impairments that are associated with the condition.

2.10. How is selection history represented in the brain?

The neural correlates of value-driven attention are reviewed more

extensively in Anderson (2019). Briefly, value-driven attention is mediated by a network of brain regions including early visual cortex (Itthipuripat et al., 2019; Kim and Anderson, 2020a;, b; Serences, 2008; Serences and Saproo, 2010; Kim et al., 2021c), extrastriate and ventral visual cortex (Anderson et al., 2014a; Anderson, 2017d; Barbaro et al., 2017; Donohue et al., 2016; Hickey and Peelen, 2015, 2017; Kim and Anderson, 2020a, b; Kim et al., 2021c), the caudate tail (Anderson et al., 2014a, 2016d; Anderson, 2017d; Kim and Anderson, 2020a, b; Kim et al., 2021c; Kim and Hikosaka, 2013; Yamamoto et al., 2013), substantial nigra (Barbaro et al., 2017; Hickey and Peelen, 2015, 2017; Kim et al., 2021c), ventral striatum (Hickey and Peelen, 2017; Meffert et al., 2018), amygdala (Peck and Salzman, 2014), posterior parietal cortex (Anderson et al., 2014a, 2016d; Anderson, 2017d; Barbaro et al., 2017; Kim and Anderson, 2020a, b; Kim et al., 2021c; Lee and Shomstein, 2013; Qi et al., 2013), and the frontal eye field (Kim and Anderson, 2020a; Kim et al., 2021c). Dopamine signaling in the striatum in particular plays an important role in both the learning (Anderson et al., 2017b) and expression (Anderson et al., 2016d) of value-driven attention, with dopaminergic reward-prediction errors (see, e.g., O'Doherty, 2004; Schultz et al., 1997) serving as teaching signals updating future priority calculations through feedback to visual areas responsible for signaling value-based attentional priority (Anderson, 2017d). Reward feedback modulates visual priming on the subsequent trial (e.g., Hickey et al., 2010a, b, 2011, 2014; Hickey and Peelen, 2017), mediated by neutral activity in the ventral striatum (Hickey and Peelen, 2017; Meffert et al., 2018), which likely reflects a more immediate consequence of this feedback mechanism (a possibility we further explore later in the text).

Incorporating both neurophysiological and psychophysical evidence, Anderson (2019) argued for two signaling pathways underlying value-based attentional priority, one biasing competition in a spatial priority map (as hypothesized by Awh et al., 2012) and another biasing rapid and automatic eye movements more directly through a pathway encompassing the visual cortex, caudate tail, and superior colliculus. With feedback from dopaminergic reward-prediction errors, reward-predictive stimuli come to evoke stronger responses in the visual cortex which then propagates to spatial priority maps in the posterior parietal cortex and frontal eye field, competing with stimulus-driven and goal-directed influences on priority. Dopamine-mediated plasticity in the ventral visual cortex and caudate tail provides a second source of bias, each of which increases the likelihood that a previously reward-predictive stimulus will reach the threshold for triggering an orienting response. Ultimately, priority computations in these two pathways are integrated and influence each other (e.g., bidirectional connections exist between the frontal eye field and superior colliculus; Sommer and Wurtz, 2001, 2004). The specific contribution of the amygdala is less understood but may serve to further modulate stimulus-evoked responses in the ventral pathway.

Recently, attentional orienting to signals for threat was shown to recruit the same constellation of brain regions as value-driven attention (Kim et al., 2021c), with an indistinguishable pattern of activation by direct comparison. This suggests a common mechanism for orienting attention to valent stimuli, which is further supported by behavioral evidence as described in the following section. Novel stimuli have also been shown to elicit a dopamine response in the striatum, possibly reflecting a broader experience-dependent salience signal (e.g., Bunzeck and Duzel, 2006; Guitart-Masip et al., 2010; Horvitz, 2000; Wittmann et al., 2008; Zink et al., 2003), in addition to novelty-dependent activation in the frontal cortex (e.g., Daffner et al., 1998, 2000).

The hippocampus, which runs adjacent to the caudate tail (Seger, 2013), and surrounding medial temporal lobe structures are strongly implicated in contextual cueing (e.g., Chun, 2000; Chun and Phelps, 1999; Negash et al., 2015; Preston and Gabrieli, 2008; Rosero et al., 2019), which in turn influence processing in visual and parietal cortex (e.g., Kasper et al., 2015; Manelis and Reder, 2012; Olson et al., 2001). Feedback-related signals in the putamen, also a structure within the

striatum of the basal ganglia, have been demonstrated in the context of learning to predict the location of the target on the basis of distractor context in contextual cueing, implicating a similar prediction-error learning mechanism (Sommer and Pollmann, 2016). Orienting to a familiar target appears not to recruit the striatum and in particular the caudate tail, although similar visuo-cortical and parietal recruitment is evident comparing to value-driven attention (Kim and Anderson, 2019c); modulation of stimulus-evoked activation in the visual and parietal cortex is similarly implicated in inter-trial priming (e.g., Brinkhuis et al., 2020; Campana et al., 2002, 2006; Eimer et al., 2010; Kristjansson et al., 2007; Rorden et al., 2011; Walsh et al., 2000). The neural mechanisms of learned suppression of frequent distractor locations and features are only beginning to be explored, but there is some evidence for spatially-specific proactive suppression in visual areas in anticipation of a distractor appearing at a high-probability location (Wang et al., 2019b) as well as more efficient ignoring of frequent distractors as reflected in reduced distractor-specific visually-evoked activity (van Moorselaar and Slagter, 2019).

2.11. Does selection history reflect a single mechanism of control or multiple?

As the definition proposed in Section 2.1 underscores, "selection history" is a broad term that can be applied to a wide range of experience-driven attentional phenomena, consistent with its use within the field of attentional control. On the one hand, this breadth serves a clear purpose in framing theory, as it distinguishes experience-driven attention from goal-directed and stimulus-driven attention (Awh et al., 2012). On the other hand, an important question that is easily glossed over in this trichotomy framework concerns whether selection history is best characterized as a single overarching attentional process or multiple. To make things concrete, Awh et al. (2012) depicted the control of attention as reflecting three sources of input to a common priority map–current goals, physical salience, and selection history–with each being represented by a box. Selection history is arguably quite a bit broader in scope than the other two mechanisms of goal-directed and stimulus-driven control–as a single box, it would be quite large with diverse contents. The question we are posing here is: how should the contents of this box be organized in developing a mechanistic framework for the control of attention?

Although there is much left to uncover with respect to this question, which reflects an important area of research that we believe is likely to play a substantive role in shaping the future of theories concerning the control of attention, some early findings concerning this question suggest a few productive distinctions. The first, and perhaps best supported, is a distinction between attention to previously reward-predictive stimuli and attention to former targets. Several sources of evidence point to a dissociation here. Most prominently, in an antisaccade task, history as a former target (of antisaccades) biases overt attention away from the stimulus, whereas associating the same stimulus with reward biases overt attention toward the stimulus (Kim & Anderson, 2019a). This suggests that attention to previously reward-associated stimuli is driven by associative learning between a stimulus and an outcome, whereas attention to former targets is driven by stimulus–response (S-R) habit learning. Further consistent with a dissociation between these two orienting processes in the experience-driven control of attention, value-driven attention is context-dependent (Anderson, 2015a, b) while target history effects are not (Anderson and Britton, 2019), and the influence of reward history but not history as a former target is blunted with symptoms of depression (Anderson et al., 2014b, 2017a). More broadly, reward history and history as a former target can give rise to dissociable patterns of behavioral performance (MacLean and Giesbrecht, 2015a). Value-driven attention is linked to dopamine signaling within the striatum (Anderson et al., 2014a, 2016d, 2017b; Hickey and Peelen, 2015) whereas target history effects are not (Kim and Anderson, 2019c), consistent with value-dependent modulation of responses to

familiar objects in caudate tail neurons involved in controlling eye movements (Kim and Hikosaka, 2013; Yamamoto et al., 2013, 2012).

An additional question that has been probed in the literature on this issue concerns the relationship between reward learning and aversive conditioning in the control of attention. Even when studied in separate experiments, the similarities between the two types of learning with respect to how the orienting of attention is affected is striking. For example, aversive conditioning creates the same orienting bias as reward in an antisaccade task, reflecting a bias to orient toward a signal for a valent outcome rather than negative reinforcement of the orienting response (Kim and Anderson, 2019a, 2021a). The effects of both reward history (Anderson, 2015a, b) and aversive conditioning (Grégoire et al., 2021c) on the control of attention are modulated by the context during learning. When directly compared in the same study, attentional bias driven by reward history and aversive conditioning consistently present with a similar behavioral profile, producing the same pattern of performance (e.g., Liao et al., 2020b; Grégoire and Anderson, 2019; Grégoire et al., 2021a, b; Wentura et al., 2014). Strikingly, when the neural correlates of attentional bias driven by reward history and aversive conditioning are directly compared, a common network of brain regions is evident with no differences observed between the two (Kim et al., 2021c). Consistent with drawing upon a common attentional resource, threat interferes with the ability of previously reward-associated stimuli to capture attention (Kim and Anderson, 2020a, c), even though it potentiates attentional capture by physically salient stimuli (thereby indicating a selective influence on value-driven attention; Kim and Anderson, 2020c; Lee et al., 2012, 2014; Mather and Sutherland, 2011; Sutherland and Mather, 2012, 2015; see also Kim et al., 2021b). Thus, although the valent outcome responsible for the resulting attentional bias is quite different in the case of reward and aversive outcomes, ultimately producing a bias toward approach and avoidance behavior, respectively (Chen and Bargh, 1999; Elliot and Covington, 2001; Guitart-Masip et al., 2014), the manner in which these outcomes shape the control of attention appears much the same. It therefore appears that valence, rather than reward learning or aversive conditioning per se, drives attention, with signals for valent (possibly survival-relevant) outcomes gaining priority.

Other components of experience-driven attention are not so directly tied to a stimulus-evoked orienting response or stimulus-specific priority, such as contextual cueing (e.g., Chun and Jiang, 1998, 2003), statistical learning of frequent target and distractor locations (e.g., Geng and Behrmann, 2002, 2005; Jiang, 2018; Jiang et al., 2013b, 2015a; Jiang and Swallow, 2013; Wang and Theeuwes, 2018a, b, c), the frequency of attention shifts (Sali et al., 2013, 2015), and the perseveration of a search mode (Cosman and Vecera, 2013; Leber and Egeth, 2006a, b; Leber et al., 2009). In such cases, there appears to be a display-wide computation of priority that takes the relation among stimuli into account (see also Becker, 2010; Becker et al., 2010, 2013; Burnham, 2007). This potentially reflects a third class of selection history-driven influences on the control of attention in which priority is computed relationally through mutual interactions among competing stimulus input. There is some evidence that, in addition to stimulus-evoked orienting, such learned relational processing can also guide attention to consistent targets (Liao et al., 2020a). Consistent with an at least partially overlapping source of priority within domain, statistical regularities in the frequency of target and distractor locations have indirect effects on each other (Ferrante et al., 2018), and consistent with distinct effects compared to value-driven attention, value and target location probability (Stankevich and Geng, 2014) as well as value and distractor location probability (, b) have additive effects on attention. Further consistent with a distinction between value-based effects and statistical regularities, value-driven attentional capture is magnified in individuals with low visual working memory capacity (Anderson et al., 2011b, 2013a; Anderson and Yantis, 2012) and when working memory resources are consumed (Watson et al., 2019a) while the influence of distractor-location probabilities and repeated search contexts is either

unimpaired (Gao and Theeuwes, 2020; Manginelli et al., 2013) or blunted (Manginelli et al., 2013; Travis et al., 2013) with a concurrent working memory load. There is also evidence that reward learning can have facilitatory effects on contextual cueing (Bergmann et al., 2020; Pollmann et al., 2016; Tseng and Lleras, 2013) that are not reducible to reward modulating priority for a frequent target location divorced from context (Sharifian et al., 2017). This third distinction in experience-driven mechanisms of attentional control is admittedly a prima facia account based off of surface-level features of the underlying attentional processes, and more evidence will be needed to substantiate and refine it.

Where does inter-trial priming fit within this framework, which is conspicuously on an entirely different timescale? Inter-trial priming was highlighted as one of two major sources of evidence (along with value-dependent effects) in favor of the distinction between selection history and the other two overarching mechanisms of attentional control (Awh et al., 2012). On the surface, inter-trial priming is the only component of experience-driven attention under the umbrella of selection history, at least as conceptualized within the framework we offer in this review paper, that is not the product of a reshaping of attentional priority built up from an accumulation of prior experience. It can be evident following a single exposure to a stimulus on a trial. Although effects of stimulus novelty on the control of attention can operate over short timescales and may reflect, at least in part, biases arising from recent experience (e.g., Horstmann and Ansorge, 2006, 2016; Horstmann, 2002), it is also clear that longer-term effects of novelty on attention are also observable (Anderson et al., 2012; Folk and Remington, 2015; Lin et al., 2016; Neo and Chua, 2006), more defensibly tying it to the other components of experience-driven attention with respect to its timescale. Above-and-beyond a common ability to distinguish inter-trial priming from goal-directed and stimulus-driven influences on the control of attention (Awh et al., 2012), how exactly should inter-trial priming fit within a more detailed, mechanistic framework for selection history?

One interesting hypothesis that we will forward here is that perhaps inter-trial priming is itself related to the teaching signals that are responsible for the development of other selection history-dependent effects, and this is what binds them to a core attentional process. In essence, inter-trial priming is a byproduct of the learning processes underlying the different experience-driven attentional processes discussed in this review. For example, the effects of reward history on attention are hypothesized to involve feedback-related signals in the visual system arising from striatal dopamine response to reward (Anderson, 2017d, 2019). An obvious prediction arising from the link we are proposing here is that trial-by-trial variation in reward should strongly modulate inter-trial priming, and this is well-supported in the literature (Hickey et al., 2010a, b, 2011, 2014, 2015; Hickey and Peelen, 2017; Hickey and van Zoest, 2012, 2013). Another prediction that arises is that inter-trial priming should involve both facilitating orienting to a prior target and facilitating inhibition of a prior distractor, since each of these selection biases are subject to learning-dependent effects of selection history (e.g., Anderson et al., 2011b; Della Libera and Chelazzi, 2009; Sha and Jiang, 2016; Vatterott and Vecera, 2012; Wang and Theeuwes, 2018a, b, c), and this is clearly the case (Kristjansson and Driver, 2008; Lamy et al., 2008; Maljkovic and Nakayama, 1996). A third prediction, which is borne out of the distinction between associative and S-R learning in the control of attention, is that each of these components should be separately evident in inter-trial priming, one operating over priority assigned to stimulus features in the context of competition-for-selection and one operating over the orienting response as an action, which maps nicely onto dual-stage accounts of inter-trial priming (e.g., Becker et al., 2014; Gokce et al., 2014; Lamy et al., 2010; Meeter and Olivers, 2006). Admittedly, our account linking inter-trial priming to other components of experience-driven attention is largely post-hoc, explaining already well-documented features of inter-trial priming. An enterprising prediction to arise from the proposed framework here is that essentially every other component of experience-driven attention should have some measurable effect on inter-trial priming during the course of learning, which is ripe for further investigation. Our account can also explain why experience-driven effects can apparently arise very early in learning only to quickly plateau (e.g., Failing et al., 2015; Jiang et al., 2013b; Le Pelley et al., 2015; Nissens et al., 2017; Sauter et al., 2019; Wang et al., 2019a), which on the surface would seem to imply learning that is unrealistically fast; such a rapid influence of selection history could be explained by the teaching signals underlying the ultimate bias having an immediate potentiating influence on inter-trial priming.

2.12. Do findings concerning selection history call for a reinterpretation of prior research?

Prior to the selection history revolution described in the Introduction (Section 1.3), attention-related phenomena tended to be attributed to either goal-directed or stimulus-driven processes. In light of what we have learned as a field concerning selection history, selection history likely played a significant role in producing the pattern of data observed across a wide range of attention studies that never discussed it or intended to manipulate it. One prominent example concerns history as a former target. In many attention paradigms, the target-defining feature is fixed and either repeats across all trials in a block (e.g., Anderson and Folk, 2012a; Folk & Remington, 1998; Folk et al., 1992; Wolfe et al., 1989) or randomly alternates between one of a small range of possibilities (e.g., Folk and Anderson, 2010; Irons et al., 2012). Under such conditions, both inter-trial priming and history as a former target are likely to drive attention in addition to any goal-directed influences on the current trial, leading to patterns of behavior and neural correlates that do not necessarily reflect the goal-directed attentional processes to which they were attributed (see Belopolsky et al., 2010; Theeuwes, 2013). Another prominent example concerns the motivational effects of reward and the anxiety-related effects of threat on attention (e.g., Eysenck et al., 2007; Jimura et al., 2010; Kiss et al., 2009; Kristjansson et al., 2010; Locke and Braver, 2008; Pessoa, 2009; Pessoa and Engelmann, 2010). To the degree to which such outcomes can be attributed to predictive stimuli such as search targets or stimuli appearing in a preceding search display more generally (thereby serving as a predictive cue), effects attributed to motivation-related influences on goal-directed attention might be more accurately attributed to value- and threat-based attentional orienting, especially when the effects involve facilitated attentional processing of targets (e.g., Kiss et al., 2009; Kristjansson et al., 2010; Pessoa and Engelmann, 2010). These and related issues are discussed in greater depth in Anderson (2018). Other components of selection history, such as novelty, the frequency of targets and distractors appearing at particular locations, or statistical regularities among stimuli, are routinely controlled for (often counterbalanced) in the design of attention studies and are unlikely to have played an unanticipated role in most cases.

So where do we go from here? On the one hand, as attention researchers become increasing cognizant of the multifaceted role that selection history can play in shaping the control of attention, its role will be more effectively isolated when it is of interest and more effectively controlled or otherwise accounted for when it is not. This is true even within the context of different components of experience-driven attention. For example, early studies on value-driven attention tended to underestimate the influence of prior target status on attention even with shorter training phases (e.g., Anderson et al., 2011b, 2013b; Anderson and Yantis, 2012; Laurent et al., 2015; Yantis et al., 2012), with subsequent studies revealing the importance of controlling for status as a former target when measuring effects of reward history (e.g., Sha and Jiang, 2016; Grubb and Li, 2018). Similar changes can be made to paradigms investigating goal-directed attention, for example by cuing the target-defining feature unpredictably trial-to-trial and requiring use of the cue to perform the task (e.g., Anderson and Folk, 2014; Anderson et al., 2016a, b; Lien et al., 2010). At the same time, conclusions

concerning attention studies not strategically accounting for selection history-related effects should be interpreted with caution and in some cases perhaps revisited with updated experimental designs.

3. Towards an integrated account

In this review, we offer a framework for conceptualizing the role of selection history in the control of attention. We present a formal definition of what constitutes selection history, and expound upon what we identify as seven *components of experience-driven attention* that collectively reflect this theoretical construct. We describe what is known about these seven components, with an eye toward comparing and contrasting them in the search for underlying themes. Here we provide a summary of some of our key conclusions, which lead to an integrated model of attentional control with an expanded characterization of selection history (Fig. 1).

The evidence distinguishing each individual component of experience-driven attention from goal-directed and stimulus-driven attention is compelling (Section 2.2), clearly affirming the theoretical distinction drawn by Awh et al. (2012) and expanding this distinction to components of experience-driven attention not explicitly addressed in their foundational paper (which predominantly focused on inter-trial priming and value-driven attention). At the same time, we argue that goal-directed and stimulus-driven attention play an integral role in our understanding of experience-driven attention by gating what is learned and/or becomes habitual (Section 2.2). Specifically, without first prioritizing a stimulus or otherwise robustly representing it in the context of biased competition, the learning mechanisms underlying experience-driven attention will not receive the input necessary to shape priority. Goal-directed and stimulus-driven priority in many cases provide this necessary input during the learning process. In this respect, although they are clearly theoretically distinct, we think it would be mistaken to truly consider selection history independently of other mechanisms of attentional control, particularly in the context of learning.

Selection history can influence attention early in the computation of priority, although such effects often do not appear to be tantamount to a change in low-level salience that might be hypothesized from plasticity at the level of the earliest stages of sensory information processing (Section 2.5). In this sense, selection history effects likely predominantly reflect biases occurring at least at middle stages of information processing and/or some measure of feedback processing, although the speed with which experience-driven priority is computed is still quite rapid and capable of robustly competing with feedback from goal-directed mechanisms. Selection history influences are clearly not limited to the visual system, with the influence of multiple components having been demonstrated in more than one sensory system (Section 2.4), although outside of vision the full scope of selection history remains to be explored.

In the computation of attentional priority, selection history can clearly exert an influence on both enhancement and suppression (Section 2.3). An interesting question can be posed concerning the relationship between the two: do enhancement and suppression reflect distinctions among fundamentally different components of experience-driven attention, or do different components of experience-driven attention jointly influence enhancement and suppression? Although this is very much an open and debatable question, we are of the mindset that the extant evidence more so favors the latter position (Section 2.3), which is a distinction that is reflected in our theoretical model (Fig. 1).

A consistent theme underlying the influence of selection history on attention is implicit learning. Although there is some evidence that explicit learning may modulate experience-driven attention in some cases, perhaps modulating input during the learning process via goal-directed attention as hypothesized above, the evidence that selection history can bias attention with limited or no awareness of the history that gave rise to the bias is compelling across a broad range of components of experience-driven attention (Section 2.6). Experience-driven attention therefore appears to be a largely unconscious mechanism of assigning priority to stimuli, which may serve as an important complement to the much more deliberate mechanism of goal-directed
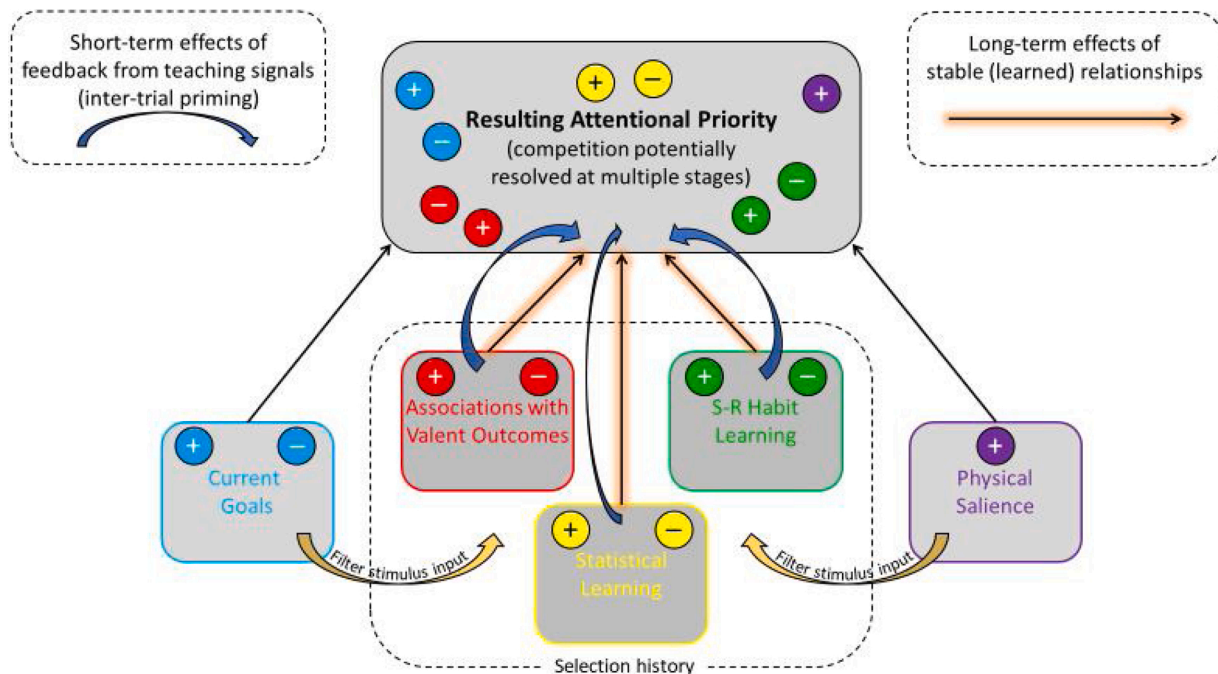

Fig. 1. Proposed model of attentional control. Selection history is broken down into three distinct mechanistic influences on attention priority, each capable of both upweighting and downweighting the priority of stimuli (orange-glowing arrows). Aside from themselves influencing priority, current goals and physical salience filter which stimulus inputs are subject to the learning-dependent plasticity that underlies each of the three overarching components of selection history (gold curved arrows). Short-term effects of feedback from the teaching signals that shape the three overarching components of selection history give rise to inter-trial priming effects on priority (blue curved arrows).

attentional control.

Selection history influences the computation of attentional priority across a variety of levels of representation and is likely tied to the level of representation that is either the most diagnostic in the prediction of an outcome or the most useful for achieving task goals during the course of learning (Section 2.4). This includes elementary features such as color and orientation, simple shapes, complex objects, and even scene semantics, as well as representations of space and even oculomotor commands themselves. At the same time, there is some suggestive evidence, at least in the context of reward learning and aversive conditioning, for a bias towards modulating information processing at somewhat later stages of visual cortical information processing than would be expected based on minimally diagnostic features (Section 2.4); this suggests a bias towards modulating the representation of a valent stimulus at the level of an integrated object, a level of representation for which this component of selection history may be optimized. What is clear from the evidence, however, is that experience-driven attentional biases cannot be thought of as arising from a single level of representation, even when considering a single component such as value-driven attention, with the possibility for multiple influences of selection history affecting priority at different stages of information processing when viewing a single image.

This latter assertion raises an important point concerning how different mechanisms of attentional control are related. Awh et al. (2012) represented attentional priority using a single priority map to which the influence of current goals, selection history, and physical salience jointly contribute and compete with one another. Although the map was intended to be an abstracted conceptual depiction of the competition for priority, it raises important questions concerning the nature and scope of this competition. Subsequent theoretical models of attentional control have retained depictions of a common map-like representation where competition between goal-driven, experience-driven, and stimulus-driven priority ensures (e.g., Failing and Theeuwes, 2018; Theeuwes, 2018, 2019), and it can be tempting to interpret such depictions literally and assume a "master map" in which the vast majority of the critical competition takes place. In our model, we emphasize the distributed nature of this competition. Competition for selection occurs at multiple levels of representation in sensory systems, and selection history clearly influences the processing of sensory information at multiple levels of representation (Sections 2.4. and 2.10). There are prominent cortical and subcortical influences of selection history on information processing (Section 2.10). At least in the context of the influence of reward and punishment learning on attention, such subcortical influences bypass representations in parietal and frontal cortex often characterized as reflecting a general priority map, with these components of experience-driven attention likely reflected in at least two different streams of visual information processing (see Anderson, 2019).

Assigning competition between different mechanisms of attentional control to a single map-like representation is likely in many cases an oversimplification. As an example, the influence of goals and physical salience may compete in priority maps in the posterior parietal cortex and frontal eye field, with the result of that competition then competing with value-driven and stimulus-driven influences arriving at the superior colliculus via a separate, ventral stream of information processing through the caudate tail. In the end, all three mechanisms of attentional control indeed compete with each other in the computation of priority, which prior models depict conceptually (e.g., Awh et al., 2012); importantly, however, that competition plays itself out dynamically over multiple stages–with different elements of that competition resolved at different stages–such that a direct three-way competition between goals, physical salience, and selection history does not necessarily play out in any single map-like representation.

Among the seven components of experience-driven attention, several relationships and distinctions emerge. The influences of reward and punishment on attention appear to be best characterized as reflecting a single overarching mechanism reflecting associative learning between stimuli and valent outcomes (Section 2.11). Generally, such valence-dependent bias takes the form of elevated priority afforded to valent stimuli, although suppression of valent stimuli has been noted in certain circumstances (Section 2.3). This can be contrasted with the influence of history as a former target on attention, which produces as dissociable pattern of orienting consistent with S-R habit learning (Section 2.11). Statistical learning may reflect a third mechanism, biasing attention toward the likely location of a target and downweighting priority at the likely location of a distractor, taking relational information into account (Section 2.11). We have argued that inter-trial priming may reflect more transient influences of the learning processes responsible for updating attentional priority with respect to these mechanisms (Section 2.11). These distinctions are reflected in our model (Fig. 1).

Where does the influence of stimulus novelty fit into our framework? At this stage in the development of the literature, we think the answer to that question is unclear. It could naturally reflect a consequence of statistical learning shaping the computation of attentional priority, in this case based on a violation of expectations. Given that novel stimuli also evoke a dopamine response in the striatum, similar to that which has been linked to value-driven attention, there may also be a parallel between attention to novel stimuli and the influence of reward on attention (Section 2.10); this would fit with the at times sluggish influence of novelty on attention that is not always evident until after the first saccade (Section 2.3), assuming the need for feedback from the striatum to the visual system. From our interpretation of the evidence presented in this review, there is insufficient evidence to suggest that novelty reflects its own distinct mechanism of experience-driven attention, and given the plausibility of linking it to other hypothesized mechanisms, we do not think that our proposed model (Fig. 1) explicitly overlooks it.

More generally, it is worth noting that in some situations experience-driven attention may reflect multiple of these underlying mechanisms acting jointly. For example, reward history (valence) and status as a former target (S-R habit learning) may come to jointly bias attention when finding a sought target was rewarded during training (Kim and Anderson, 2019a), and perhaps both S-R habit learning and statistical learning bias attention toward more frequent target locations in visual search (Jiang, 2018; Jiang et al., 2013b, 2015a; Jiang and Swallow, 2013). Of course, when the target of visual search is also associated with reward, is characterized by a feature that has consistently defined a target over trials, or consistently appears at a particular spatial location, at least one mechanism of selection history and goal-directed attention may jointly influence selection. Similarly, any stimulus that is prioritized by attention by virtue of its relation to current goals or learning history can also be physically salient. Our proposed model (Fig. 1) should not be taken to suggest that any given instance of attentional orienting must be fit into a single box, and this is true both within the context of different mechanisms that fall under the umbrella of selection history and between such mechanisms and the other two mechanisms of goal-directed and stimulus-driven attention.

Our proposed model (Fig. 1) focuses on understanding selection history, and a detailed mechanistic discussion concerning the influence of current goals and physical salience on the control of attention is beyond the scope of this review. With that said, our model should not be taken to imply that goal-directed and stimulus-driven mechanisms of attentional control could not be themselves deconstructed into component parts, much like selection history is in our model. For example, goal-directed feature-based attention (e.g., Liu et al., 2003) can be distinguished from goal-directed spatial attention (e.g., Foster et al., 2020), and physical salience exists at multiple levels of representation from local feature contrast (e.g., Theeuwes, 2010) to emergent features (e.g., Pomerantz et al., 1977). In this sense, selection history is by no means unique in terms of the utility of deconstructing the mechanism into component parts.

We have made the case that all of the different components of experience-driven attention can be considered as an adaptation and that

the influence of selection history as a mechanism of attentional control is therefore wholly adaptive (Section 2.8). The apparently high susceptibility to distraction afforded by the influence of reward and punishment learning on attention likely reflects particulars of experiment design that are important for distinguishing between different theoretical accounts of the phenomenon but are ultimately ecologically questionable. The manner in which selection history influences attention may be influenced by built-in mechanisms that favor either exploiting prior learning or exploring in the midst of uncertainty depending on task context, which follows a dynamic overall priority weighting that might be expected of an adaptive system. This distinction fits naturally with the priority state space framework hypothesized by Todd and Manaligod (2018), which assumes a nested hierarchy of goals, the organization of which collectively determines the assignment of priority.

The issue of adaptiveness is also worth considering in the context of mechanisms of attentional control more broadly, as it provides a single overarching framework for understanding how the influence of current goals, selection history, and physical salience are related to one another and jointly determine priority. With respect to task goals, it is generally held that representations in active memory, either visual working memory or activated long-term memory, bias attention toward stimuli that share features with these representations (e.g., Olivers et al., 2006, 2011; Reinhart and Woodman, 2015; Woodman and Arita, 2011; Woodman et al., 2013). When an organism biases attention in this matter, outcomes will naturally tend to be better than when the organism does not, provided there is some relationship between what is held in active memory and current biological needs (either to approach or to avoid). In fact, it is conceivable that organisms could learn to prioritize stimuli that share representational overlap with information held in active memory through experience, although this of course need not be the case and the relationship might instead reflect an organization of neural connections favored over the course of evolution. In the case of physical salience, physically salient objects could reflect unexpected dangers or opportunities that an organism is advantaged to attend to and consider when deciding how to act, such as a predator leaping out of hiding. A more robust representation of stronger (more salient) sensory input that in turn influences competition for selection may simply reflect a mere downstream consequence of how our sensory organs respond to sensory events. However, a much more restricted range of stimulus-evoked activity that would minimize the influence of salience or a computation of attentional priority that more strongly downweights the influence of physical salience is of course conceivable, but appears not to have not been favored over the course of evolution; this suggests that the influence of physical salience on attention is at least somewhat adaptive. In this sense, goal-directed and salience-driven mechanisms of attentional control along with all three of our hypothesized mechanisms of experience-driven attention (Fig. 1) can be thought of collectively as different adaptations applied unto the processing of sensory information that jointly determine selection.

3.1. Outstanding issues and future directions

The focus of this review has been on examples of experience-driven attention that can be distinguished from goal-directed and stimulus-driven influences on the control of attention. As outlined in our criteria for defining a component of experience-driven attention, the attentional bias in question should not be explainable by appealing to the influence of prior experience on the modulation of task goals, such as intentionally searching for something that has been learned to be predictive of reward. Invariably, this leads to a framework for selection history that emphasizes phenomena more akin to stimulus-driven processes by which a particular stimulus or class of stimuli are involuntarily prioritized on the basis of past experience. The influence of past experience on the shaping of goal-directed attentional processes is quite interesting in its own right and may reflect a unique domain of selection history. Future research should seek to explore this aspect of selection

history more systematically.

The aforementioned consideration highlights a broader issue that has been touched upon previously, which is that in many situations attention is the joint product of multiple mechanisms of control either working together or competing against each other. Although each of the components of experience-driven attention discussed in this review is individually well-supported as a distinct influence on the computation of attentional priority, the dynamics by which different mechanisms of attentional control interact is largely unexplored; this is true both within the domain of selection history and between selection history and goal-directed and stimulus-driven attention. Different aspects of goal-directed attention (e.g., feature-based and spatial) and different dimensions of salience (e.g., basic feature contrast, higher-level shape contrast, abrupt onset, emergent features) could differently interact with the learning and expression of experience-driven attention. Within the domain of selection history, one particularly pertinent relationship concerns the link between target history (S-R habit learning) and reward history (association with valent outcome), which naturally overlap when an individual learns about the value tied to task-relevant stimuli. Although each of these mechanisms clearly exerts a unique influence on the control of attention (see esp. Sections 2.1, 2.2, and 2.11), ostensibly very similar experiment conditions in some cases favor a value-dependent influence overshadowing an influence of target history (e. g., Anderson and Halpern, 2017) and in other cases an influence of target history overshadowing an influence of value (e.g., Grubb and Li, 2018; Sha and Jiang, 2016); understanding this apparent discrepancy requires a more detailed understanding of the specific factors and conditions that favor each of these two mechanisms of experience-driven attention when they are simultaneously engaged. The development of a mechanistic understanding of the relationships between and interactions among the different influences on attentional priority clearly reflects another important area for future research.

Although some progress has been made (e.g., Anderson, 2019), our understanding of the neural mechanisms of experience-driven attention is still somewhat limited–especially outside of the context of value-driven attention–and significantly lags behind our understanding of the neural mechanisms of stimulus-driven and goal-directed attention (e.g., Corbetta and Shulman, 2002; Desimone and Duncan, 1995; Serences et al., 2005). Mechanisms of experience-driven stimulus suppression are particularly less understood compared to experience-driven mechanisms that bias attention in favor of stimuli, although these suppressive mechanisms reflect an area of intense research interest that will likely see significant progress in the years to come. Several more specific unresolved issues that would benefit from further research focus were raised in the corresponding sub-sections throughout Section 2.

3.2. Considerations for future scientific discourse

In this review, we balance a holistic conceptualization of selection history with a fractionated conceptualization of its individual components, which our proposed framework seeks to organize mechanistically. We would argue that each of these reflects an important and valuable framework for conceptualizing the control of attention, depending on the scope of the question being asked. If the question involves drawing a distinction between the attention effect in question and goal-directed and/or stimulus-driven influences, a trichotomy framework invoking selection history without further qualification can be productive (Awh et al., 2012). If the intent is to provide a mechanistic description of the attention effect under investigation per se, we would advocate for the utility of a more qualified framework, and our proposed model provides one possible framework that could be adopted to this end. More broadly, simply describing a consequence of past experience on attention as constituting selection history without further qualification is likely to impede scientific progress and generate confusion within the field concerning the mechanisms the authors believe to be responsible for the effect in question. Our recommendation would be that any use of the

term "selection history" be accompanied by a clear description of the presumed underlying mechanism, particularly with respect to the different components of experience-driven attention highlighted in this review.

Funding

Declaration of Competing Interest

The authors report no declarations of interest.

References

Abado, E., Sagi, J., Silber, N., De Houwer, J., Aue, T., Okon-Singer, H., 2020. Reducing attention bias in spider fear by manipulating expectancies. Behav. Res. Ther. 135, 103729.

Addleman, D.A., Jiang, Y.V., 2019a. Experience-driven auditory attention. Trends Cogn. Sci. 23, 927–937.

Addleman, D.A., Jiang, Y.V., 2019b. The influence of selection history on auditory spatial attention. J. Exp. Psychol. Hum. Percept. Perform. 45, 474–488.

Ahissar, M., Hochstein, S., 1993. Attentional control of early perceptual learning. Proc. Natl. Acad. Sci. U. S. A. 90, 5718–5722.

Albertella, L., Copeland, D., Pearson, D., Watson, P., Wiers, R.W., Le Pelley, M.E., 2017. Selective attention moderates the relationship between attentional capture by signals of nondrug reward and illicit drug use. Drug Alcohol Depend. 175, 99–105.

Albertella, L., Le Pelley, M.E., Chamberlain, S.R., Westbrook, F., Fontenelle, L.F., Segrave, R., et al., 2019a. Reward-related attentional capture is associated with severity of addictive and obsessive-compulsive behaviors. Psychol. Addict. Behav. 33, 495–502.

Albertella, L., Watson, P., Yucel, M., Le Pelley, M.E., 2019b. Persistence of value-modulated attentional capture is associated with risky alcohol use. Addict. Behav. Rep. 10, 100195.

Albertella, L., Chamberlain, S.R., Le Pelley, M.E., Greenwood, L.-M., Lee, R.S.C., Den Ouden, L., et al., 2020. Compulsivity is measurable across distinct psychiatric symptom domains and is associated with familial risk and reward-related attentional capture. CNS Spectr. 25, 519–526.

Alho, K., Escera, C., Diaz, R., Yago, E., Serra, J.M., 1997. Effects of involuntary auditory attention on visual task performance and brain activity. NeuroReport 8, 3233–3237.

Anderson, B.A., 2013. A value-driven mechanism of attentional selection. J. Vis. 13 (3), 1–16, 7.

Anderson, B.A., 2014. On the precision of goal-directed attentional selection. J. Exp. Psychol. Hum. Percept. Perform. 40, 1755–1762.

Anderson, B.A., 2015a. Value-driven attentional capture is modulated by spatial context. Vis. Cogn. 23, 67–81.

Anderson, B.A., 2015b. Value-driven attentional priority is context specific. Psychon. Bull. Rev. 22, 750–756.

Anderson, B.A., 2016a. Social reward shapes attentional biases. Cogn. Neurosci. 7, 30–36.

Anderson, B.A., 2016b. The attention habit: how reward learning shapes attentional selection. Ann. N. Y. Acad. Sci. 1369, 24–39.

Anderson, B.A., 2016c. Value-driven attentional capture in the auditory domain. Atten. Percept. Psychophys. 78, 242–250.

Anderson, B.A., 2016d. What is abnormal about addiction-related attentional biases? Drug Alcohol Depend. 167, 8–14.

Anderson, B.A., 2017a. Counterintuitive effects of negative social feedback on attention. Cogn. Emot. 31, 590–597.

Anderson, B.A., 2017b. Going for it: the economics of automaticity in perception and action. Curr. Dir. Psychol. Sci. 26, 140–145.

Anderson, B.A., 2017c. On the feature specificity of value-driven attention. PLoS One 12, e0177491.

Anderson, B.A., 2017d. Reward processing in the value-driven attention network: reward signals tracking cue identity and location. Soc. Cogn. Affect. Neurosci. 12, 461–467.

Anderson, B.A., 2018. Controlled information processing, automaticity, and the burden of proof. Psychon. Bull. Rev. 25, 1814–1823.

Anderson, B.A., 2019. Neurobiology of value-driven attention. Curr. Opin. Psychol. 29, 27–33.

Anderson, B.A., 2021a. Linking value-driven attention to psychopathology. Curr. Opin. Psychol. 39, 48–54.

Anderson, B.A., 2021b. Using aversive conditioning with near-real-time feedback to shape eye movements during naturalistic viewing. Behav. Res. Methods 53, 993–1002.

Anderson, B.A., Britton, M.K., 2019. Selection history in context: evidence for the role of reinforcement learning in biasing attention. Atten. Percept. Psychophys. 81, 2666–2672.

Anderson, B.A., Britton, M.K., 2020. On the automaticity of attentional orienting to threatening stimuli. Emotion 20, 1109–1112.

Anderson, B.A., Folk, C.L., 2010. Variations in the magnitude of attentional capture: testing a two-process model. Atten. Percept. Psychophys. 72, 342–352.

Anderson, B.A., Folk, C.L., 2012a. Contingent involuntary motoric inhibition: the involuntary inhibition of a motor response contingent on top-down goals. J. Exp. Psychol. Hum. Percept. Perform. 38, 1348–1352.

Anderson, B.A., Folk, C.L., 2012b. Dissociating location-specific inhibition and attention shifts: evidence against the disengagement account of contingent capture. Atten. Percept. Psychophys. 74, 1183–1198.

Anderson, B.A., Folk, C.L., 2014. Conditional automaticity in response selection: contingent involuntary response inhibition with varied stimulus-response mapping. Psychol. Sci. 25, 547–554.

Anderson, B.A., Halpern, M., 2017. On the value-dependence of value-driven attentional capture. Atten. Percept. Psychophys. 79, 1001–1011.

Anderson, B.A., Kim, H., 2018a. Mechanisms of value-learning in the guidance of spatial attention. Cognition 178, 26–36.

Anderson, B.A., Kim, H., 2018b. On the representational nature of value-driven spatial attentional biases. J. Neurophysiol. 120, 2654–2658.

Anderson, B.A., Kim, H., 2018c. Relating attentional biases for stimuli associated with social reward and punishment to autistic traits. Collabra Psychol. 4 (1) article 10.

Anderson, B.A., Kim, H., 2019a. On the relationship between value-driven and stimulus-driven attentional capture. Atten. Percept. Psychophys. 81, 607–613.

Anderson, B.A., Kim, H., 2019b. Test-retest reliability of value-driven attentional capture. Behav. Res. Methods 51, 720–726.

Anderson, B.A., Kim, A.J., 2020. Selection history-driven signal suppression. Vis. Cogn. 28, 112–118.

Anderson, B.A., Yantis, S., 2012. Value-driven attentional and oculomotor capture during goal-directed, unconstrained viewing. Atten. Percept. Psychophys. 74, 1644–1653.

Anderson, B.A., Yantis, S., 2013. Persistence of value-driven attentional capture. J. Exp. Psychol. Hum. Percept. Perform. 39, 6–9.

Anderson, B.A., Laurent, P.A., Yantis, S., 2011a. Learned value magnifies salience-based attentional capture. PLoS One 6, e27926.

Anderson, B.A., Laurent, P.A., Yantis, S., 2011b. Value-driven attentional capture. Proc. Natl. Acad. Sci. U. S. A. 108, 10367–10371.

Anderson, B.A., Laurent, P.A., Yantis, S., 2012. Generalization of value-based attentional priority. Vis. Cogn. 20, 647–658.

Anderson, B.A., Faulkner, M.L., Rilee, J.J., Yantis, S., Marvel, C.L., 2013a. Attentional bias for non-drug reward is magnified in addiction. Exp. Clin. Psychopharmacol. 21, 499–506.

Anderson, B.A., Laurent, P.A., Yantis, S., 2013b. Reward predictions bias attentional selection. Front. Hum. Neurosci. 7 (262).

Anderson, B.A., Laurent, P.A., Yantis, S., 2014a. Value-driven attentional priority signals in human basal ganglia and visual cortex. Brain Res. 1587, 88–96.

Anderson, B.A., Leal, S.L., Hall, M.G., Yassa, M.A., Yantis, S., 2014b. The attribution of value-based attentional priority in individuals with depressive symptoms. Cogn. Affect. Behav. Neurosci. 14, 1221–1227.

Anderson, B.A., Folk, C.L., Courtney, S.M., 2016a. Neural mechanisms of goal-contingent task disengagement: response-irrelevant stimuli activate the default mode network. Cortex 81, 221–230.

Anderson, B.A., Folk, C.L., Garrison, R., Rogers, L., 2016b. Mechanisms of habitual approach: failure to suppress irrelevant responses evoked by previously reward-associated stimuli. J. Exp. Psychol. Gen. 145, 796–805.

Anderson, B.A., Kronemer, S.I., Rilee, J.J., Sacktor, N., Marvel, C.L., 2016c. Reward, attention, and HIV-related risk in HIV+ individuals. Neurobiol. Dis. 92, 157–165.

Anderson, B.A., Kuwabara, H., Wong, D.F., Gean, E.G., Rahmim, A., Brasic, J.R., George, N., Frolov, B., Courtney, S.M., Yantis, S., 2016d. The role of dopamine in value-based attentional orienting. Curr. Biol. 26, 550–555.

Anderson, B.A., Chiu, M., DiBartolo, M.M., Leal, S.L., 2017a. On the distinction between value-driven attention and selection history: evidence from individuals with depressive symptoms. Psychon. Bull. Rev. 24, 1636–1642.

Anderson, B.A., Kuwabara, H., Wong, D.F., Roberts, J., Rahmim, A., Brasic, J.R., Courtney, S.M., 2017b. Linking dopaminergic reward signals to the development of attentional bias: a positron emission tomographic study. NeuroImage 157, 27–33.

Anderson, B.A., Kim, H., Britton, M.K., Kim, A.J., 2020. Measuring attention to reward as an individual trait: the value-driven attention questionnaire (VDAQ). Psychol. Res. 84, 2122–2137.

Arsenault, J.T., Nelissen, K., Jarraya, B., Vanduffel, W., 2013. Dopaminergic reward signals selectively decrease fMRI activity in primate visual cortex. Neuron 77, 1174–1186.

Asutay, E., Vastfjall, D., 2016. Auditory attentional selection is biased by reward cues. Sci. Rep. 6, 36989.

Awh, E., Pashler, H., 2000. Evidence for split attentional foci. J. Exp. Psychol. Hum. Percept. Perform. 26, 834–846.

Awh, E., Belopolsky, A.V., Theeuwes, J., 2012. Top-down versus bottom-up attentional control: a failed theoretical dichotomy. Trends Cogn. Sci. 16, 437–443.

Bachman, M.D., Wang, L., Gamble, M.L., Woldorff, M.G., 2020. Physical salience and value-driven salience operate through distinct neural mechanisms to enhance attentional selection. J. Neurosci. 40, 5455–5464.

Barbaro, L., Peelen, M.V., Hickey, C., 2017. Valence, not utility, underlies reward-driven prioritization in human vision. J. Neurosci. 37, 10438–10450.

Baskin-Sommers, A.R., Curtin, J.J., Newman, J.P., 2011. Specifying the attentional selection that moderates the fearlessness of psychopathic offenders. Psychol. Sci. 22, 226–234.

Baskin-Sommers, A., Curtin, J.J., Li, W., Newman, J.P., 2012. Psychopathy-related differences in selective attention are captured by an early event-related potential. Personal. Disord. Theory Res. Treat. 3, 370–378.

Becker, S.I., 2010. The role of target–distractor relationships in guiding attention and the eyes in visual search. J. Exp. Psychol. Gen. 139, 247–265.

Becker, S.I., Folk, C.L., Remington, R.W., 2010. The role of relational information in contingent capture. J. Exp. Psychol. Hum. Percept. Perform. 36, 1460–1476.

Becker, S.I., Folk, C.L., Remington, R.W., 2013. Attentional capture does not depend on feature similarity, but on target-nontarget relations. Psychol. Sci. 24, 634–647.

Becker, S.I., Grubert, A., Dux, P.E., 2014. Distinct neural networks for target feature versus dimension changes in visual search, as revealed by EEG and fMRI. NeuroImage 102, 798–808.

Becker, M.W., Hemsteger, S.H., Chantland, E., Liu, T., 2020. Value-based attention capture: differential effects of loss and gain contingencies. J. Vis. 20 (5), 1–13, 4.

Belke, E., Humphreys, G.W., Watson, D.G., Meyer, A.S., Telling, A.L., 2008. Top-down effects of semantic knowledge in visual search are modulated by cognitive but not perceptual load. Percept. Psychophys. 70, 1444–1458.

Belopolsky, A.V., Schreij, D., Theeuwes, J., 2010. What is top-down about contingent capture? Atten. Percept. Psychophys. 72, 326–341.

Bergmann, N., Tünnermann, J., Schubö, A., 2020. Reward-predicting distractor orientations support contextual cueing: persistent effects in homogeneous distractor contexts. Vision Res. 171, 53–63.

Bourgeois, A., Neveu, R., Vuilleumier, P., 2016. How does awareness modulate goal-directed and stimulus-driven shifts of attention triggered by value learning? PLoS One 11, e0160469.

Bourgeois, A., Neveu, R., Bayle, D.J., Vuilleumier, P., 2017. How does reward compete with goal-directed and stimulus-driven shifts of attention? Cogn. Emot. 31, 109–118.

Bourgeois, A., Badier, E., Baron, N., Carruzzo, F., Vuilleumier, P., 2018a. Influence of reward learning on visual attention and eye movements in a naturalistic environment: a virtual reality study. PLoS One 13, e0207990.

Bourgeois, A., Saj, A., Vuilleumier, P., 2018b. Value-driven attentional capture in neglect. Cortex 109, 260–271.

Brady, T.F., Chun, M.M., 2007. Spatial constraints on learning in visual search: modeling contextual cuing. J. Exp. Psychol. Hum. Percept. Perform. 33, 798–815.

Brinkhuis, M.A.B., Kristjansson, A., Harvey, B.M., Brascamp, J.W., 2020. Temporal characteristics of priming of attention shifts are mirrored by BOLD response patterns in the frontoparietal attention network. Cereb. Cortex 30, 2267–2280.

Britton, M.K., Anderson, B.A., 2020. Specificity and persistence of statistical learning in distractor suppression. J. Exp. Psychol. Hum. Percept. Perform. 46, 324–334.

Britton, M.K., Anderson, B.A., 2021. Attentional avoidance of threatening stimuli. Psychol. Res. 85, 82–90.

Broadbent, D.E., 1958. Perception and Communication. Oxford University Press, New York.

Brockmole, J.R., Henderson, J.M., 2006a. Recognition and attentional guidance during contextual cueing in real-world scenes: evidence from eye movements. Q. J. Exp. Psychol. 59, 1177–1187.

Brockmole, J.R., Henderson, J.M., 2006b. Using real-world scenes as contextual cues for search. Vis. Cogn. 13, 99–108.

Brockmole, J.R., Castelhano, M.S., Henderson, J.M., 2006. Contextual cueing in natural scenes: global and local contexts. J. Exp. Psychol. Learn. Mem. Cogn. 32, 699–706.

Bromberg-Martin, E.S., Hikosaka, O., 2009. Midbrain dopamine neurons signal preference for advance information about upcoming rewards. Neuron 63, 119–126.

Brooks, D.I., Rasmussen, I.P., Hollingworth, A., 2010. The nesting of search context within natural scenes: evidence from contextual cuing. J. Exp. Psychol. Hum. Percept. Perform. 36, 1406–1418.

Brown, C.R.H., Berggren, N., Forster, S., 2020. Testing a goal-driven account of involuntary attentional capture by threat. Emotion 20, 572–589.

Bucker, B., Theeuwes, J., 2014. The effect of reward on orienting and reorienting in exogenous cuing. Cogn. Affect. Behav. Neurosci. 14, 635–646.

Bucker, B., Theeuwes, J., 2017. Pavlovian reward learning underlies value driven attentional capture. Atten. Percept. Psychophys. 79, 415–428.

Bucker, B., Belopolsky, A.V., Theeuwes, J., 2015a. Distractors that signal reward attract the eyes. Vis. Cogn. 23, 1–24.

Bucker, B., Silvis, J.D., Donk, M., Theeuwes, J., 2015b. Reward modulates oculomotor competition between differently valued stimuli. Vision Res. 108, 103–112.

Bundesen, C., 1990. A theory of visual attention. Psychol. Rev. 97, 523–547.

Bunzeck, N., Duzel, E., 2006. Absolute coding of stimulus novelty in the human substantia nigra/VTA. Neuron 51, 369–379.

Burnham, B.R., 2007. Displaywide visual features associated with a search display's appearance can mediate attentional capture. Psychon. Bull. Rev. 14, 392–422.

Campana, G., Cowey, A., Walsh, V., 2002. Priming of motion direction and area V5/MT: a test of perceptual memory. Cereb. Cortex 12, 663–669.

Campana, G., Cowey, A., Walsh, V., 2006. Visual area V5/MT remembers "what" but not "where". Cereb. Cortex 16, 1766–1770.

Carsten, T., Hoofs, V., Boehler, C.N., Krebs, R.M., 2019. Are losses more effective than rewards in improving performance in a cognitive task? Motiv. Sci. 5, 257–268.

Chelazzi, L., Estocinova, J., Calletti, R., Lo Gerfo, E., Sani, I., Della Libera, C., Santandrea, E., 2014. Altering spatial priority maps via reward-based learning. J. Neurosci. 34, 8594–8604.

Chen, M., Bargh, J.A., 1999. Consequences of automatic evaluation: immediate behavioral predispositions to approach or avoid the stimulus. Pers. Soc. Psychol. Bull. 25, 215–224.

Cheng, F.P.-H., Saglam, A., Andre, S., Pooresmaeili, A., 2020. Cross-modal integration of reward value during oculomotor planning. eNeuro 7. ENEURO.0381-19.2020.

Cherry, E.C., 1953. Some experiments on the recognition of speech, with one and with two ears. J. Acoust. Soc. Am. 25, 975–979.

Chun, M.M., 2000. Contextual cueing of visual attention. Trends Cogn. Sci. 4, 170–178.

Chun, M.M., Jiang, Y.H., 1998. Contextual cueing: implicit learning and memory of visual context guides spatial attention. Cogn. Psychol. 36, 28–71.

Chun, M.M., Jiang, Y.H., 1999. Top-down attentional guidance based on implicit learning of visual covariation. Psychol. Sci. 10, 360–365.

Chun, M.M., Jiang, Y., 2003. Implicit, long-term spatial contextual memory. J. Exp. Psychol. Learn. Mem. Cogn. 29, 224–234.

Chun, M.M., Phelps, E.A., 1999. Memory deficits for implicit contextual information in amnesic subjects with hippocampal damage. Nat. Neurosci. 2, 844–847.

Cichy, R.M., Chen, Y., Haynes, J.-D., 2011. Encoding the identity and location of objects in human LOC. NeuroImage 54, 2297–2307.

Colagiuri, B., Livesey, E.J., 2016. Contextual cuing as a form of nonconscious learning: theoretical and empirical analysis in large and very large samples. Psychon. Bull. Rev. 23, 1996–2009.

Connor, C.E., Egeth, H.E., Yantis, S., 2004. Visual attention: bottom-up vs. top-down. Curr. Biol. 14, 850–852.

Corbetta, M., Shulman, G.L., 2002. Control of goal-directed and stimulus-driven attention in the brain. Nat. Rev. Neurosci. 3, 201–215.

Cosman, J.D., Vecera, S.P., 2013. Context-dependent control over attentional capture. J. Exp. Psychol. Hum. Percept. Perform. 39, 836–848.

Cosman, J.D., Vecera, S.P., 2014. Establishment of an attentional set via statistical learning. J. Exp. Psychol. Hum. Percept. Perform. 40, 1–6.

Daddaoua, N., Lopes, M., Gottlieb, J., 2016. Intrinsically motivated oculomotor exploration guided by uncertainty reduction and conditioned reinforcement in non-human primates. Sci. Rep. 6, 20202.

Daffner, K.R., Mesulam, M.M., Scinto, L.F.M., Cohen, L.G., Kennedy, B.P., West, W.C., Holcomb, P.J., 1998. Regulation of attention to novel stimuli by frontal lobes: an event-related potential study. Neuroreport 9, 787–791.

Daffner, K.R., Mesulam, M.M., Holcomb, P.J., Calvo, V., Acar, D., Chabrerie, A., Kikinis, R., Jolesz, F.A., Rentz, D.M., Scinto, L.F., 2000. Disruption of attention to novel events after frontal lobe injury in humans. J. Neurol. Neurosurg. Psychiatry 68, 18–24.

de Groot, F., Huettig, F., Olivers, C.N.L., 2016. When meaning matters: the temporal dynamics of semantic influences on visual attention. J. Exp. Psychol. Hum. Percept. Perform. 42, 180–196.

De Tommaso, M., Mastropasqua, T., Turatto, M., 2017. The salience of a reward cue can outlast reward devaluation. Behav. Neurosci. 131, 226–234.

De Tommaso, M., Mastropasqua, T., Turatto, M., 2019. Multiple reward–cue contingencies favor expectancy over uncertainty in shaping the reward–cue attentional salience. Psychol. Res. 83, 332–346.

Debener, S., Kranczioch, C., Herrmann, C.S., Engel, A.K., 2002. Auditory novelty oddball allows reliable distinction of top-down and bottom-up processes of attention. Int. J. Psychophysiol. 46, 77–84.

Della Libera, C., Chelazzi, L., 2006. Visual selective attention and the effects of monetary rewards. Psychol. Sci. 17, 222–227.

Della Libera, C., Chelazzi, L., 2009. Learning to attend and to ignore is a matter of gains and losses. Psychol. Sci. 20, 778–784.

Della Libera, C., Perlato, A., Chelazzi, L., 2011. Dissociable effects of reward on attentional learning: from passive associations to active monitoring. PLoS One 6, e19460.

Della Libera, C., Calletti, R., Estocinova, J., Chelazzi, L., Santandrea, E., 2017. Reward-based plasticity of spatial priority maps: exploiting inter-subject variability to probe the underlying neurobiology. Cogn. Neurosci. 8, 85–101.

Desimone, R., Duncan, J., 1995. Neural mechanisms of selective visual attention. Annu. Rev. Neurosci. 18, 193–222.

Devue, C., Belopolsky, A.V., Theeuwes, J., 2011. The role of fear and expectancies in capture of covert attention by spiders. Emotion 11, 768–775.

Doan, L.A., 2014. Auditory Temporal Contextual Cueing. University of Manitoba. https://mspace.lib.umanitoba.ca/bitstream/handle/1993/23977/Doan_Lori.pdf?sequence=1.

Dodgson, D.B., Raymond, J.E., 2020. Value associations bias ensemble perception. Atten. Percept. Psychophys. 82, 109–117.

Donohue, S.E., Hopf, J.M., Bartsch, M.V., Schoenfeld, M.A., Heinze, H.J., Woldorff, M.G., 2016. The rapid capture of attention by rewarded objects. J. Cogn. Neurosci. 28, 529–541.

Egeth, H.E., Yantis, S., 1997. Visual attention: control, representation, and time course. Annu. Rev. Psychol. 48, 269–297.

Eimer, M., Kiss, M., 2008. Involuntary attentional capture is determined by task set: evidence from event-related brain potentials. J. Cogn. Neurosci. 20, 1423–1433.

Eimer, M., Kiss, M., 2010. Top-down search strategies determine attentional capture in visual search: behavioral and electrophysiological evidence. Atten. Percept. Psychophys. 72, 951–962.

Eimer, M., Kiss, M., Cheung, T., 2010. Priming of pop-out modulates attentional target selection in visual search: behavioural and electrophysiological evidence. Vision Res. 50, 1353–1361.

Elliot, A.J., Covington, M.V., 2001. Approach and avoidance motivation. Educ. Psychol. Rev. 13, 73–92.

Ernst, D., Becker, S., Horstmann, G., 2020. Novelty competes with saliency for attention. Vision Res. 168, 42–52.

Esterman, M., Reagan, A., Liu, G., Turner, C., DeGutis, J., 2014. Reward reveals dissociable aspects of sustained attention. J. Exp. Psychol. Gen. 143, 2287–2295.

Esterman, M., Grosso, M., Liu, G., Mitko, A., Morris, R., DeGutis, J., 2016. Anticipation of monetary reward can attenuate the vigilance decrement. PLoS One 11 (7), e0159741.

Esterman, M., Poole, V., Liu, G., DeGutis, J., 2017. Modulating reward induces differential neurocognitive approaches to sustained attention. Cereb. Cortex 27, 4022–4032.

Etzel, J.A., Cole, M.W., Zacks, J.M., Kay, K.N., Braver, T.S., 2016. Reward motivation enhances task coding in frontoparietal cortex. Cereb. Cortex 26, 1647–1659.

Eysenck, M.W., Derakshan, N., Santos, R., Calvo, M.G., 2007. Anxiety and cognitive performance: attentional control theory. Emotion 7, 336–353.

Failing, M.F., Theeuwes, J., 2014. Exogenous visual orienting by reward. J. Vis. 14 (5:6), 1–9.

Failing, M.F., Theeuwes, J., 2015. Nonspatial attentional capture by previously rewarded scene semantics. Vis. Cogn. 23, 82–104.

Failing, M., Theeuwes, J., 2017. Don't let it distract you: how information about the availability of reward affects attentional selection. Atten. Percept. Psychophys. 79, 2275–2298.

Failing, M., Theeuwes, J., 2018. Selection history: how reward modulates selectivity of visual attention. Psychon. Bull. Rev. 25, 514–538.

Failing, M., Nissens, T., Pearson, D., Le Pelley, M., Theeuwes, J., 2015. Oculomotor capture by stimuli that signal the availability of reward. J. Neurophysiol. 114, 2316–2327.

Failing, M., Feldmann-Wustefeld, T., Wang, B., Olivers, C., Theeuwes, J., 2019a. Statistical regularities induce spatial as well as feature-specific suppression. J. Exp. Psychol. Hum. Percept. Perform. 45, 1291–1303.

Failing, M., Wang, B., Theeuwes, J., 2019b. Spatial suppression due to statistical regularities is driven by distractor suppression not by target activation. Atten. Percept. Psychophys. 81, 1405–1414.

Fan, J.E., Turk-Browne, N.B., 2016. Incidental biasing of attention from visual long-term memory. J. Exp. Psychol. Learn. Mem. Cogn. 42, 970–977.

Farroni, T., Johnson, M.H., Menon, E., Zulian, L., Faraguna, D., Csibra, G., 2005. Newborns' preference for face-relevant stimuli: effects of contrast polarity. Proc. Natl. Acad. Sci. U. S. A. 102, 17245–17250.

Ferrante, O., Patacca, A., Di Caro, V., Della Libera, C., Santandrea, E., Chelazzi, L., 2018. Altering spatial priority maps via statistical learning of target selection and distractor filtering. Cortex 102, 67–95.

Foley, N.C., Kelly, S.P., Mhatre, H., Lopes, M., Gottlieb, J., 2017. Parietal neurons encode expected gains in instrumental information. Proc. Natl. Acad. Sci. U. S. A. 114, E3315–E3323.

Folk, C.L., Anderson, B.A., 2010. Target uncertainty effects in attentional capture: color singleton set or multiple attentional control settings? Psychon. Bull. Rev. 17, 421–426.

Folk, C.L., Remington [W.], R., 1998. Selectivity in distraction by irrelevant featural singletons: Evidence for two forms of attentional capture. Journal of Experimental Psychology: Human Perception and Performance 24, 847–858.

Folk, C.L., Remington, R.W., 2008. Bottom-up priming of top-down attentional control settings. Vis. Cogn. 16, 215–231.

Folk, C.L., Remington, R.W., 2015. Unexpected abrupt onsets can override a top-down set for color. J. Exp. Psychol. Hum. Percept. Perform. 41, 1153–1165.

Folk, C.L., Remington, R.W., Johnston, J.C., 1992. Involuntary covert orienting is contingent on attentional control settings. J. Exp. Psychol. Hum. Percept. Perform. 18, 1030–1044.

Folk, C.L., Leber, A.B., Egeth, H.E., 2002. Made you blink! Contingent attentional capture produces a spatial blink. Percept. Psychophys. 64, 741–753.

Foster, J.J., Bsales, E.M., Awh, E., 2020. Covert spatial attention speeds target individuation. J. Neurosci. 40, 2717–2726.

Freeman, S.M., Aron, A.R., 2015. Withholding a reward-driven action: studies of the rise and fall of motor activation and the effect of cognitive depletion. J. Cogn. Neurosci. 28, 237–251.

Freeman, S.M., Razhas, I., Aron, A.R., 2014. Top-down response suppression mitigates action tendencies triggered by a motivating stimulus. Curr. Biol. 24, 212–216.

Gao, Y., Theeuwes, J., 2020. Learning to suppress a distractor is not affected by working memory load. Psychon. Bull. Rev. 27, 96–104.

Gaspelin, N., Luck, S.J., 2018. The role of inhibition in avoiding distraction by salient stimuli. Trends Cogn. Sci. 22, 79–92.

Gaspelin, N., Leonard, C.J., Luck, S.J., 2015. Direct evidence for active suppression of salient-but-irrelevant sensory inputs. Psychol. Sci. 26, 1740–1750.

Gaspelin, N., Leonard, C.J., Luck, S.J., 2017. Suppression of overt attentional capture by salient-but-irrelevant color singletons. Atten. Percept. Psychophys. 79, 45–62.

Geng, J.J., Behrmann, M., 2002. Probability cuing of target location facilitates visual search implicitly in normal participants and patients with hemispatial neglect. Psychol. Sci. 13, 520–525.

Geng, J.J., Behrmann, M., 2005. Spatial probability as an attentional cue in visual search. Percept. Psychophys. 67, 1252–1268.

Geyer, T., Muller, H., Krummenacher, J., 2006. Cross-trial priming in visual search for singleton conjunction targets: role of repeated target and distractor features. Percept. Psychophys. 68, 736–749.

Geyer, T., Muller, H., Krummenacher, J., 2007. Cross-trial priming of element positions in visual pop-out search is dependent on stimulus arrangement. J. Exp. Psychol. Hum. Percept. Perform. 33, 788–797.

Giggs, W.S., Kim, H.F., Ghazizadeh, A., Costello, M.G., Wall, K.M., Hikosaka, O., 2017. Flexible and stable value coding areas in the caudate head and tail receive anatomically distinct cortical and subcortical inputs. Front. Neuroanat. 11 (106).

Gilbert, C.D., Sigman, M., Crist, R.E., 2001. The neural basis of perceptual learning. Neuron 31, 681–697.

Gokce, A., Geyer, T., Finke, K., Mueller, H.J., Tollner, T., 2014. What pops out in positional priming of pop-out: insights from event-related EEG lateralizations. Front. Psychol. 5, 688.

Gong, M., Yang, F., Li, S., 2016. Reward association facilitates distractor suppression in human visual search. Eur. J. Neurosci. 43, 942–953.

Gong, M., Liu, T., 2018. Reward differentially interacts with physical salience in feature-based attention. J. Vis. 18 (11), 1–12, 12.

Gong, M., Jia, K., Li, S., 2017. Perceptual competition promotes suppression of reward salience in behavioral selection and neural representation. J. Neurosci. 37, 6242–6252.

Goren, C.C., Sarty, M., Wu, P.Y., 1975. Visual following and pattern discrimination of face-like stimuli by newborn infants. Pediatrics 56, 544–549.

Goschy, H., Bakos, S., Müller, H.J., Zehetleitner, M., 2014. Probability cueing of distractor locations: both intertrial facilitation and statistical learning mediate interference reduction. Front. Psychol. 5, 1–11.

Gottlieb, J., Oudeyer, P.-Y., 2018. Towards a neuroscience of active sampling and curiosity. Nat. Rev. Neurosci. 19, 758–770.

Gottlieb, J., Lopes, M., Oudeyer, P.-Y., 2016. Motivated cognition: neural and computational mechanisms of curiosity, attention, and intrinsic motivation. In: Kim, S., Reeve, J., Bong, M. (Eds.), Recent Developments in Neuroscience Research on Human Motivation (Advances in Motivation and Achievement, Vol. 19). Emerald Group Publishing Limited, pp. 149–172.

Grabenhorst, F., Rolls, E.T., Margot, C., 2011. A hedonically complex odor mixture produces an attentional capture effect in the brain. NeuroImage 55, 832–843.

Grégoire, L., Anderson, B.A., 2019. Semantic generalization of value-based attentional priority. Learn. Mem. 26, 460–464.

Grégoire, L., Britton, M.K., Anderson, B.A., 2021a. Motivated suppression of value- and threat-modulated attentional capture. Emotion. https://doi.org/10.1037/emo0000777.

Grégoire, L., Kim, A.J., Anderson, B.A., 2021b. Semantic generalization of punishment-related attentional priority. Vis. Cogn. 29, 310–317.

Grégoire, L., Kim, H., Anderson, B.A., 2021c. Punishment-modulated attentional capture is context-specific. Motiv. Sci. 7, 165–175.

Grill-Spector, K., 2010. The neural basis of object perception. Curr. Opin. Neurobiol. 13, 159–166.

Grubb, M.A., Li, Y., 2018. Assessing the role of accuracy-based feedback in value-driven attentional capture. Atten. Percept. Psychophys. 80, 822–828.

Guitart-Masip, M., Bunzeck, N., Stephan, K.E., Dolan, R.J., Duzel, E., 2010. Contextual novelty changes reward representations in the striatum. J. Neurosci. 30, 1721–1726.

Guitart-Masip, M., Duzel, E., Dolan, R., Dayan, P., 2014. Action versus valence in decision making. Trends Cogn. Sci. 18, 194–202.

Harris, A.M., Remington, R.W., 2017. Contextual cueing improves attentional guidance, even when search is supposedly optimal. J. Exp. Psychol. Hum. Percept. Perform. 43, 926–940.

Harris, J.A., Donohue, S.E., Schoenfeld, M.A., Hopf, J.-M., Heinze, H.-J., Woldorff, M.G., 2016. Reward associated features capture attention in the absence of awareness: evidence from object-substitution masking. NeuroImage 137, 116–123.

Hayward, D.A., Pereira, E.J., Otto, A.R., Ristic, J., 2018. Smile! Social reward drives attention. J. Exp. Psychol. Hum. Percept. Perform. 44, 206–214.

Hickey, C., Peelen, M.V., 2015. Neural mechanisms of incentive salience in naturalistic human vision. Neuron 85, 512–518.

Hickey, C., Peelen, M.V., 2017. Reward selectively modulates the lingering neural representation of recently attended objects in natural scenes. J. Neurosci. 37, 7297–7304.

Hickey, C., van Zoest, W., 2012. Reward creates oculomotor salience. Curr. Biol. 22, R219–220.

Hickey, C., van Zoest, W., 2013. Reward-associated stimuli capture the eyes in spite of strategic attentional set. Vision Res. 92, 67–74.

Hickey, C., Di Lollo, V., McDonald, J.J., 2009. Electrophysiological indices of target and distractor processing in visual search. J. Cogn. Neurosci. 21, 760–775.

Hickey, C., Chelazzi, L., Theeuwes, J., 2010a. Reward changes salience in human vision via the anterior cingulate. J. Neurosci. 30, 11096–11103.

Hickey, C., Chelazzi, L., Theeuwes, J., 2010b. Reward guides vision when it's your thing: trait reward-seeking in reward-mediated visual priming. PLoS One 5, e14087.

Hickey, C., Chelazzi, L., Theeuwes, J., 2011. Reward has a residual impact on target selection in visual search, but not on the suppression of distractors. Vis. Cogn. 19, 117–128.

Hickey, C., Chelazzi, L., Theeuwes, J., 2014. Reward-priming of location in visual search. PLoS One 9, e103372.

Hickey, C., Kaiser, D., Peelen, M.V., 2015. Reward guides attention to object categories in real-world scenes. J. Exp. Psychol. Gen. 144, 264–273.

Higuchi, Y., Ueda, Y., Shibata, K., Saiki, J., 2020. Spatial variability induces generalization in contextual cueing. J. Exp. Psychol. Learn. Mem. Cogn. 46, 2295–2313.

Hills, T.T., Todd, P.M., Lazer, D., Redish, A.D., Couzin, I.D., The Cognitive Search Research Group, 2015. Exploration versus exploitation in space, mind, and society. Trends Cogn. Sci. 19, 46–54.

Hillstrom, A.P., 2000. Repetition effects in visual search. Percept. Psychophys. 62, 800–817.

Hopf, J.-M., Schoenfeld, A., Buschschulte, A., Rautzenberg, A., Krebs, R.M., Boehler, C. N., 2015. The modulatory impact of reward and attention on global feature selection in human visual cortex. Vis. Cogn. 23, 229–248.

Hopkins, L.S., Helmstetter, F.J., Hannula, D.E., 2016. Eye movements are captured by a perceptually simple conditioned stimulus in the absence of explicit contingency knowledge. Emotion 16, 1157–1171.

Horan, M., Daddaoua, N., Gottlieb, J., 2019. Parietal neurons encode information sampling based on decision uncertainty. Nat. Neurosci. 22, 1327–1335.

Horstmann, G., 2002. Evidence for attentional capture by a surprising color singleton in visual search. Psychol. Sci. 13, 499–505.

Horstmann, G., Ansorge, U., 2006. Attentional shifts to rare singletons. Vis. Cogn. 14, 295–325.

Horstmann, G., Ansorge, U., 2016. Surprise capture and inattentional blindness. Cognition 157, 237–249.

Horstmann, G., Herwig, A., 2016. Novelty biases attention and gaze in a surprise trial. Atten. Percept. Psychophys. 78, 69–77.

Horvitz, J.C., 2000. Mesolimbocortical and nigrostriatal dopamine responses to salient non-reward events. Neuroscience 96, 651–656.

Hubel, D.H., Wiesel, T.N., 1962. Receptive fields, binocular interaction, and functional architecture in the cat visual cortex. J. Physiol. 160, 106–154.

Hutchinson, J.B., Turk-Browne, N.B., 2012. Memory-guided attention: control from multiple memory systems. Trends Cogn. Sci. 16, 576–579.

Irons, J.L., Folk, C.L., Remington, R.W., 2012. All set! Evidence of simultaneous attentional control settings for multiple target colors. J. Exp. Psychol. Hum. Percept. Perform. 38, 758–775.

Itthipuripat, S., Cha, K., Rangsipat, N., Serences, J.T., 2015. Value-based attentional capture influences context dependent decision-making. J. Neurophysiol. 114, 560–569.

Itthipuripat, S., Vo, V.A., Sprague, T.C., Serences, J.T., 2019. Value-driven attentional capture enhances distractor representations in early visual cortex. PLoS Biol. 17, e3000186.

Itti, L., Koch, C., 2001. Computational modelling of visual attention. Nat. Rev. Neurosci. 2, 194–203.

Jefferies, L.N., Enns, J.T., Di Lollo, V., 2014. The flexible focus: whether spatial attention is unitary or divided depends on observer goals. J. Exp. Psychol. Hum. Percept. Perform. 40, 465–470.

Jiang, Y.V., 2018. Habitual versus goal-driven attention. Cortex 102, 107–120.

Jiang, Y., Chun, M.M., 2001. Selective attention modulates implicit learning. Q. J. Exp. Psychol. 54, 1105–1124.

Jiang, Y., Leung, A.W., 2005. Implicit learning of ignored visual context. Psychon. Bull. Rev. 12, 100–106.

Jiang, Y.V., Swallow, K.M., 2013. Spatial reference frame of incidentally learned attention. Cognition 126, 378–390.

Jiang, Y., Wagner, L.C., 2004. What is learned in spatial contextual cuing—Configuration or individual locations? Percept. Psychophys. 66, 454–463.

Jiang, Y.V., Swallow, K.M., Rosenbaum, G.M., 2013a. Guidance of spatial attention by incidental learning and endogenous cueing. J. Exp. Psychol. Hum. Percept. Perform. 39, 285–297.

Jiang, Y.V., Swallow, K.M., Rosenbaum, G.M., Herzig, C., 2013b. Rapid acquisition but slow extinction of an attentional bias in space. J. Exp. Psychol. Hum. Percept. Perform. 39, 87–99.

Jiang, Y.V., Won, B.-Y., Swallow, K.M., 2014. First saccadic eye movement reveals persistent attentional guidance by implicit learning. J. Exp. Psychol. Hum. Percept. Perform. 40, 1161–1173.

Jiang, Y.V., Li, Z.S., Remington, R.W., 2015a. Modulation of spatial attention by goals, statistical learning, and monetary reward. Atten. Percept. Psychophys. 77, 2189–2206.

Jiang, Y.V., Swallow, K.M., Won, B.-Y., Cistera, J.D., Rosenbaum, G.M., 2015b. Task specificity of attention training: the case of probability cuing. Atten. Percept. Psychophys. 77, 50–66.

Jiao, J., Du, F., He, X., Zhang, K., 2015. Social comparison modulates reward-driven attentional capture. Psychon. Bull. Rev. 22, 1278–1284.

Jimura, K., Locke, H.S., Braver, T.S., 2010. Prefrontal cortex mediation of cognitive enhancement in rewarding motivational contexts. Proc. Natl. Acad. Sci. U. S. A. 107, 8871–8876.

Johnson, E.N., Hawken, M.J., Shapley, R., 2008. The orientation selectivity of color-responsive neurons in macaque V1. J. Neurosci. 28, 8096–8106.

Johnston, W.A., Schwarting, I.S., 1997. Novel popout: an enigma for conventional theories of attention. J. Exp. Psychol. Hum. Percept. Perform. 23, 622–631.

Johnston, W.A., Hawley, K.J., Plewe, S.H., Elliott, J.M.G., DeWitt, M.J., 1990. Attention capture by novel stimuli. J. Exp. Psychol. Gen. 119, 397–411.

Johnston, W.A., Hawley, K.J., Farnham, J.M., 1993. Novel popout: empirical boundaries and tentative theory. J. Exp. Psychol. Hum. Percept. Perform. 19, 140–153.

Jones, J.L., Kaschak, M.P., 2012. Global statistical learning in a visual search task. J. Exp. Psychol. Hum. Percept. Perform. 38, 152–160.

Jonides, J., 1981. Voluntary versus automatic control over the mind's eye's movement. In: Long, J.B., Baddeley, A.D. (Eds.), Attention and Performance IX. Erlbaum, Hillsdale, NJ, pp. 187–203.

Jungé, J.A., Scholl, B.J., Chun, M.M., 2007. How is spatial context learning integrated over signal versus noise? A primacy effect in contextual cuing. Vis. Cogn. 15, 1–11.

Kasper, R.W., Grafton, S.T., Eckstein, M.P., Giesbrecht, B., 2015. Multimodal neuroimaging evidence linking memory and attention systems during visual search cued by context. Ann. N. Y. Acad. Sci. 1339, 176–189.

Kim, H., Anderson, B.A., 2019a. Dissociable components of experience-driven attention. Curr. Biol. 29, 841–845.

Kim, H., Anderson, B.A., 2019b. Neural evidence for automatic value-modulated approach behavior. NeuroImage 189, 150–158.

Kim, H., Anderson, B.A., 2019c. Dissociable neural mechanisms underlie value-driven and selection-driven attentional control. Brain Res. 1708, 109–115.

Kim, A.J., Anderson, B.A., 2020a. Arousal-biased competition explains reduced distraction by reward cues under threat. eNeuro 7. ENEURO.0099-20.2020.

Kim, A.J., Anderson, B.A., 2020b. Neural correlates of attentional capture by stimuli previously associated with social reward. Cogn. Neurosci. 11, 5–15.

Kim, A.J., Anderson, B.A., 2020c. Threat reduces value-driven but not salience-driven attentional capture. Emotion 20, 874–889.

Kim, H., Anderson, B.A., 2021a. How does the attention system learn from aversive outcomes? Emotion 21, 898–903.

Kim, H., Anderson, B.A., 2021b. Combined influence of valence and statistical learning on the control of attention: evidence for independent sources of bias. Cognition 208, 104554.

Kim, S., Beck, M.R., 2020. Impact of relative and absolute values on selective attention. Psychon. Bull. Rev. 27, 735–741.

Kim, H.F., Hikosaka, O., 2013. Distinct basal ganglia circuits controlling behaviors guided by flexible and stable values. Neuron 79, 1001–1010.

Kim, A.J., Lee, D.S., Anderson, B.A., 2021a. Previously reward-associated sounds interfere with goal-directed auditory processing. Q. J. Exp. Psychol. 74, 1257–1263.

Kim, A.J., Lee, D.S., Anderson, B.A., 2021b. The influence of threat on the efficiency of goal-directed auditory processing. Psychol. Res. 85, 980–986.

Kim, H., Nanavaty, N., Ahmed, H., Mathur, V.A., Anderson, B.A., 2021c. Motivational salience guides attention to valuable and threatening stimuli: evidence from behavior and fMRI. J. Cogn. Neurosci. https://doi.org/10.1162/jocn_a_01769.

Kinchla, R.A., Wolfe, J.M., 1979. The order of visual processing: "Top-down," "bottom-up," or "middle-out". Percept. Psychophys. 25, 225–231.

Kiss, M., Driver, J., Eimer, M., 2009. Reward priority of visual target singletons modulates event-related potential signatures of attentional selection. Psychol. Sci. 20, 245–251.

Kobayashi, H., Ogawa, H., 2020. Contextual cueing facilitation arises early in the time course of visual search: an investigation with the `speed-accuracy tradeoff task. Atten. Percept. Psychophys. 82, 2851–2861.

Koenig, S., Kadel, H., Uengoer, M., Schubo, A., Lachnit, H., 2017a. Reward draws the eye, uncertainty holds the eye: associative learning modulates distractor interference in visual search. Front. Behav. Neurosci. 11 (128).

Koenig, S., Uengoer, M., Lachnit, H., 2017b. Attentional bias for uncertain cues of shock in human fear conditioning: evidence for attentional learning theory. Front. Behav. Neurosci. 11 (266).

Koster, E.H.W., Crombez, G., Van Damme, S., Verschuere, B., De Houwer, J., 2004a. Does imminent threat capture and hold attention? Emotion 4, 312–317.

Koster, E.H.W., Crombez, G., Verschuere, B., De Houwer, J., 2004b. Selective attention to threat in the dot probe paradigm: differentiating vigilance and difficulty to disengage. Behav. Res. Ther. 42, 1183–1192.

Krebs, R.M., Boehler, C.N., Woldorff, M.G., 2010. The influence of reward associations on conflict processing in the Stroop task. Cognition 117, 341–347.

Krebs, R.M., Boehler, C.N., Egner, T., Woldorff, M.G., 2011. The neural underpinnings of how reward associations can both guide and misguide attention. J. Neurosci. 31, 9752–9759.

Kristjansson, A., 2006. Simultaneous priming along multiple feature dimensions in a visual search task. Vision Res. 46, 2554–2570.

Kristjansson, A., Campana, G., 2010. Where perception meets memory: a review of repetition priming in visual search tasks. Atten. Percept. Psychophys. 72, 5–18.

Kristjansson, A., Driver, J., 2008. Priming in visual search: separating the effects of target repetition, distractor repetition and role-reversal. Vision Res. 48, 1217–1232.

Kristjansson, A., Wang, D., Nakayama, K., 2002. The role of priming in conjunctive visual search. Cognition 85, 37–52.

Kristjansson, A., Vuilleumier, P., Schwartz, S., Macaluso, E., Driver, J., 2007. Neural basis for priming of pop-out during visual search revealed with fMRI. Cereb. Cortex 17, 1612–1624.

Kristjansson, A., Sigurjonsdottir, O., Driver, J., 2010. Fortune and reversals of fortune in visual search: reward contingencies for pop-out targets affect search efficiency and target repetition effects. Atten. Percept. Psychophys. 72, 1229–1236.

Kyllingsbaek, S., Schneider, W.X., Bundesen, C., 2001. Automatic attraction of attention to former targets in visual displays of letters. Percept. Psychophys. 63, 85–98.

Kyllingsbaek, S., Van Lommel, S., Sorensen, T.A., Bundesen, C., 2014. Automatic attraction of visual attention by supraletter features of former target strings. Front. Psychol. 5 (1383), 1–7.

Lamy, D., Antebi, C., Aviani, N., Carmel, T., 2008. Priming of pop-out provides reliable measures of target activation and distractor inhibition in selective attention. Vision Res. 48, 30–41.

Lamy, D., Yashar, A., Ruderman, L., 2010. A dual-stage account of inter-trial priming effects. Vision Res. 50, 1396–1401.

Laurent, P.A., Hall, M.G., Anderson, B.A., Yantis, S., 2015. Valuable orientations capture attention. Vis. Cogn. 23, 133–146.

Le Pelley, M.E., Pearson, D., Griffiths, O., Beesley, T., 2015. When goals conflict with values: counterproductive attentional and oculomotor capture by reward-related stimuli. J. Exp. Psychol. Gen. 144, 158–171.

Le Pelley, M.E., Seabrooke, T., Kennedy, B.L., Pearson, D., Most, S.B., 2017. Miss it and miss out: counterproductive nonspatial attentional capture by task-irrelevant, value-related stimuli. Atten. Percept. Psychophys. 79, 1628–1642.

Le Pelley, M.E., Pearson, D., Porter, A., Yee, H., Luque, D., 2019a. Oculomotor capture is influenced by expected reward value but (maybe) not predictiveness. Q. J. Exp. Psychol. 72, 168–181.

Le Pelley, M.E., Watson, P., Pearson, D., Abeywickrama, R.S., Most, S.B., 2019b. Winners and losers: reward and punishment produce biases in temporal selection. J. Exp. Psychol. Learn. Mem. Cogn. 45, 822–833.

Leber, A.B., 2010. Neural predictors of within-subject fluctuations in attentional control. J. Neurosci. 30, 11458–11465.

Leber, A.B., Egeth, H.E., 2006a. Attention on autopilot: past experience and attentional set. Vis. Cogn. 14, 565–583.

Leber, A.B., Egeth, H.E., 2006b. It's under control: top-down search strategies can override attentional capture. Psychon. Bull. Rev. 13, 132–138.

Leber, A.B., Kawahara, J.I., Gabari, Y., 2009. Long-term abstract learning of attentional set. J. Exp. Psychol. Hum. Percept. Perform. 35, 1385–1397.

Leber, A.B., Gwinn, R.E., Hong, Y., O'Toole, R.J., 2016. Implicitly learned suppression of irrelevant spatial locations. Psychon. Bull. Rev. 23, 1873–1881.

Lee, J., Shomstein, S., 2013. The differential effects of reward on space- and object-based attentional allocation. J. Neurosci. 33, 10625–10633.

Lee, J., Shomstein, S., 2014. Reward-based transfer from bottom-up to top-down search tasks. Psychol. Sci. 25, 466–475.

Lee, T.H., Itti, L., Mather, M., 2012. Evidence for arousal-biased competition in perceptual learning. Front. Psychol. 3, 241.

Lee, T.H., Sakaki, M., Cheng, R., Velasco, R., Mather, M., 2014. Emotional arousal amplifies the effects of biased competition in the brain. Soc. Cogn. Affect. Neurosci. 9, 2067–2077.

Leganes-Fonteneau, M., Scott, R., Duka, T., 2018. Attentional responses to stimuli associated with a reward can occur in the absence of knowledge of their predictive values. Behav. Brain Res. 341, 26–36.

Leganes-Fonteneau, M., Nikolaou, K., Scott, R., Duka, T., 2019. Knowledge about the predictive value of reward conditioned stimuli modulates their interference with cognitive processes. Learn. Mem. 26, 66–76.

Li, A.-S., Theeuwes, J., 2020. Statistical regularities across trials bias attentional selection. J. Exp. Psychol. Hum. Percept. Perform. 46, 860–870.

Liao, M.-R., Anderson, B.A., 2020a. Inertia in value-driven attention. Learn. Mem. 27, 488–492.

Liao, M.-R., Anderson, B.A., 2020b. Reward learning biases the direction of saccades. Cognition 196, 104145.

Liao, M.-R., Britton, M.K., Anderson, B.A., 2020a. Selection history is relative. Vision Res. 175, 23–31.

Liao, M.-R., Grégoire, L., Anderson, B.A., 2020b. The influence of threat and aversive motivation on conflict processing in the Stroop task. Atten. Percept. Psychophys. 82, 2802–2813.

Liechty, M., Madhavan, P., 2011. An eye movement analysis of contextual cueing effects. In: Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 55, pp. 222–226.

Lien, M.-C., Ruthruff, E., Goodin, Z., Remington, R.W., 2008. Contingent attentional capture by top-down control settings: converging evidence from event-related potentials. J. Exp. Psychol. Hum. Percept. Perform. 34, 509–530.

Lien, M.-C., Ruthruff, E., Johnston, J.V., 2010. Attentional capture with rapidly changing attentional control settings. J. Exp. Psychol. Hum. Percept. Perform. 36, 1–16.

Lin, Z., Lu, Z.-H., He, S., 2016. Decomposing experience-driven attention: opposite attentional effects of previously predictive cues. Atten. Percept. Psychophys. 78, 2185–2198.

Lin, R., Li, X., Wang, B., Theeuwes, J., 2021. Spatial suppression due to statistical learning tracks the estimated spatial probability. Atten. Percept. Psychophys. 83, 283–291.

Liu, T., Slotnick, S.D., Serences, J.T., Yantis, S., 2003. Cortical mechanisms of feature-based attentional control. Cereb. Cortex 13, 1334-1243.

Locke, H.S., Braver, T.S., 2008. Motivational influences on cognitive control: behavior, brain activation, and individual differences. Cogn. Affect. Behav. Neurosci. 8, 99–112.

Luck, S.J., Gaspelin, N., Folk, C.L., Remington, R.W., Theeuwes, J., 2021. Progress toward resolving the attentional capture debate. Vis. Cogn. 29, 1–21.

MacLean, M.H., Giesbrecht, B., 2015a. Irrelevant reward and selection histories have different influences on task-relevant attentional selection. Atten. Percept. Psychophys. 77, 1–14.

MacLean, M.H., Giesbrecht, B., 2015b. Neural evidence reveals the rapid effects of reward history on selective attention. Brain Res. 1606, 86–94.

MacLean, M.H., Diaz, G.K., Giesbrecht, B., 2016. Irrelevant learned reward associations disrupt voluntary spatial attention. Atten. Percept. Psychophys. 78, 2241–2252.

Malach, R., Reppas, J.B., Benson, R.R., Kwong, K.K., Jiang, H., Kennedy, W.A., Ledden, P. J., Brady, T.J., Rosen, B.R., Tootell, R.B., 1995. Object-related activity revealed by functional magnetic resonance imaging in human occipital cortex. Proc. Natl. Acad. Sci. U. S. A. 92, 8135–8139.

Malcolm, G., Rattinger, M., Shomstein, S., 2016. Intrusive effects of task irrelevant semantic information on visual selective attention. Atten. Percept. Psychophys. 78, 2066–2078.

Malhotra, P.A., Soto, D., Li, K., Russell, C., 2013. Reward modulates spatial neglect. J. Neurol. Neurosurg. Psychiatry 84, 366–369.

Maljkovic, V., Nakayama, K., 1994. Priming of pop-out: I. Role of features. Mem. Cognit. 22, 657–672.

Maljkovic, V., Nakayama, K., 1996. Priming of pop-out: II. The role of position. Percept. Psychophys. 58, 977–991.

Manelis, A., Reder, L.M., 2012. Procedural learning and associative memory mechanisms contribute to contextual cueing: evidence from fMRI and eye-tracking. Learn. Mem. 19, 527–534.

Manginelli, A.A., Pollman, S., 2009. Misleading contextual cues: How do they affect visual search? Psychol. Res. 73, 212–221.

Manginelli, A.A., Langer, N., Klose, D., Pollmann, S., 2013. Contextual cueing under working memory load: selective interference of visuospatial load with expression of learning. Atten. Percept. Psychophys. 75, 1103–1117.

Marchner, J.R., Preuschhof, C., 2018. Reward history but not search history explains value-driven attentional capture. Atten. Percept. Psychophys. 80, 1436–1448.

Mather, M., Sutherland, M.R., 2011. Arousal-biased competition in perception and memory. Perspect. Psychol. Sci. 6, 114–133.

McCoy, B., Theeuwes, J., 2018. Overt and covert attention to location-based reward. Vision Res. 142, 27–39.

Meeter, M., Olivers, C.N.L., 2006. Intertrial priming stemming from ambiguity: a new account of priming in visual search. Vis. Cogn. 13, 202–222.

Meffert, H., Penner, E., VanThieghem, M.R., Sypher, I., Leshin, J., Blair, R.J.R., 2018. The role of ventral striatum in reward-based attentional bias. Brain Res. 1689, 89–97.

Mine, C., Saiki, J., 2015. Task-irrelevant stimulus-reward association induces value-driven attentional capture. Atten. Percept. Psychophys. 77, 1896–1907.

Mine, C., Saiki, J., 2018. Pavlovian reward learning elicits attentional capture by reward-associated stimuli. Atten. Percept. Psychophys. 80, 1083–1095.

Mine, C., Yokoyama, T., Takeda, Y., 2021. Awareness is necessary for attentional biases by location-reward association. Atten. Percept. Psychophys. 83, 2002–2016.

Miranda, A.T., Palmer, E.M., 2014. Intrinsic motivation and attentional capture from gamelike features in a visual search task. Behav. Res. Methods 46, 159–172.

Miskovic, V., Keil, A., 2012. Acquired fears reflected in cortical sensory processing: a review of electrophysiological studies of human classical conditioning. Psychophysiology 49, 1230–1241.

Mogg, K., Bradley, B.P., 2005. Attentional bias in generalized anxiety disorder versus depressive disorder. Cognit. Ther. Res. 29, 29–45.

Moher, J., Anderson, B.A., Song, J.-H., 2015. Dissociable effects of salience on attention and goal-directed action. Curr. Biol. 25, 2040–2046.

Moores, E., Laiti, L., Chelazzi, L., 2003. Associative knowledge controls deployment of visual selective attention. Nat. Neurosci. 6, 182–189.

Moray, N., 1959. Attention in dichotic listening: affective cues and the influence of instructions. Q. J. Exp. Psychol. 11, 56–60.

Most, S.B., Wang, L., 2011. Dissociating spatial attention and awareness in emotion-induced blindness. Psychol. Sci. 22, 300–305.

Most, S.B., Chun, M.M., Widders, D.M., Zald, D.H., 2005. Attentional rubbernecking: cognitive control and personality in emotion-induced blindness. Psychon. Bull. Rev. 12, 654–661.

Most, S.B., Smith, S.D., Cooter, A.B., Levy, B.N., Zald, D.H., 2007. The naked truth: positive, arousing distractors impair rapid target perception. Cogn. Emot. 21, 964–981.

Mulckhuyse, M., 2018. The influence of emotional stimuli on the oculomotor system: a review of the literature. Cogn. Affect. Behav. Neurosci. 18, 411–425.

Mulckhuyse, M., Dalmaijer, E.S., 2016. Distracted by danger: temporal and spatial dynamics of visual selection in the presence of threat. Cogn. Affect. Behav. Neurosci. 16, 315–324.

Mulckhuyse, M., Crombez, G., Van der Stigchel, S., 2013. Conditioned fear modulates visual selection. Emotion 13, 529–536.

Muller, S., Rothermund, K., Wentura, D., 2016. Relevance drives attention: attentional bias for gain-and loss-related stimuli is driven by delayed disengagement. Q. J. Exp. Psychol. 69, 752–763.

Munneke, J., Hoppenbrouwers, S.S., Theeuwes, J., 2015. Reward can modulate attentional capture, independent of top-down set. Atten. Percept. Psychophys. 77, 2540–2548.

Munneke, J., Belopolsky, A.V., Theeuwes, J., 2016. Distractors associated with reward break through the focus of attention. Atten. Percept. Psychophys. 78, 2213–2225.

Navalpakkam, V., Koch, C., Perona, P., 2009. Homo economicus in visual search. J. Vis. 9 (1), 1–16, 31.

Navalpakkam, V., Koch, C., Rangel, A., Perona, P., 2010. Optimal reward harvesting in complex perceptual environments. Proc. Natl. Acad. Sci. U. S. A. 107, 5232–5237.

Negash, S., Petersen, L.E., Geda, Y.E., Knopman, D.S., Boeve, B.F., Smith, G.E., Ivnik, R. J., Howard, D.V., Howard, J.H., Petersen, R.C., 2007. Effects of ApoE genotype and mild cognitive impairment on implicit learning. Neurobiol. Aging 28, 885–893.

Negash, S., Kliot, D., Howard, D.V., Howard, J.H., Das, S.R., Yushkevich, P.A., Pluta, J.B., Arnold, S.E., Wolk, D.A., 2015. Relationship of contextual cueing and hippocampal volume in amnestic mild cognitive impairment patients and cognitively normal older adults. J. Int. Neuropsychol. Soc. 21, 285–296.

Neo, G., Chua, F.K., 2006. Capturing focused attention. Percept. Psychophys. 68, 1286–1296.

Newman, J.P., Curtin, J.J., Bertsch, J.D., Baskin-Sommers, A.R., 2010. Attention moderates the fearlessness of psychopathic offenders. Biol. Psychol. 67, 66–70.

Nickel, A.E., Hopkins, L.S., Minor, G.N., Hannula, D., 2020. Attention capture by episodic long-term memory. Cognition 201, 104312.

Nissens, T., Failing, M., Theeuwes, J., 2017. People look at the object they fear: oculomotor capture by stimuli that signal threat. Cogn. Emot. 31, 1707–1714.

O'Doherty, J.P., 2004. Reward representations and reward-related learning in the human brain: insights from neuroimaging. Curr. Opin. Neurobiol. 14, 769–776.

Ohlschlager, S., Vo, M.L.H., 2020. Development of scene knowledge: evidence from explicit and implicit scene knowledge measures. J. Exp. Child Psychol. 194, 104782.

Öhman, A., Mineka, S., 2001. Fears, phobias, and preparedness: toward an evolved module of fear and fear learning. Psychol. Rev. 108, 483–522.

Olivers, C.N.L., Meijer, F., Theeuwes, J., 2006. Feature-based memory-driven attentional capture: visual working memory content affect visual attention. J. Exp. Psychol. Hum. Percept. Perform. 32, 1243–1265.

Olivers, C.N.L., Peters, J., Houtkamp, R., Roelfsema, P.R., 2011. Different states in visual working memory: when it guides attention and when it does not. Trends Cogn. Sci. 15, 327–334.

Olson, I.R., Chun, M.M., 2002. Perceptual constraints on implicit learning of spatial context. Vis. Cogn. 9, 273–302.

Olson, I.R., Chun, M.M., Allison, T., 2001. Contextual guidance of attention: human intracranial event-related potential evidence for feedback modulation in anatomically early, temporally late stages of visual processing. Brain 124, 1417–1425.

Onie, S., Peterson, M., Le Pelley, M., Most, S., 2021. Learned value and predictiveness affect gaze but not figure assignment. Atten. Percept. Psychophys. 83, 156–172.

Padmala, S., Pessoa, L., 2011. Reward reduces conflict by enhancing attentional control and biasing visual cortical processing. J. Cogn. Neurosci. 23, 3419-2432.

Parise, E., Friederici, A.D., Striano, T., 2010. "'Did you call me?'" 5-month-old infants own name guides their attention. PLoS One 5, e14208.

Park, H., Quinlan, J., Thornton, E., Reder, L.M., 2004. The effect of midazolam on visual search: implications for understanding amnesia. Proc. Natl. Acad. Sci. U. S. A. 101, 17879–17883.

Parmentier, F.B.R., Elford, G., Escera, C., Andres, P., San Miguel, I., 2008. The cognitive locus of distraction by acoustic novelty in the cross-modal oddball task. Cognition 106, 408–432.

Pascucci, D., Mastropasqua, T., Turatto, M., 2015. Monetary reward modulates task-irrelevant perceptual learning for invisible stimuli. PLoS One 10, e0124009.

Peacock, C.E., Hayes, T.R., Henderson, J.M., 2019. Meaning guides attention during scene viewing, even when it is irrelevant. Atten. Percept. Psychophys. 81, 20–34.

Pearson, D., Le Pelley, M.E., 2020. Learning to avoid looking: competing influences of reward on overt attentional selection. Psychon. Bull. Rev. 27, 998–1005.

Pearson, D., Donkin, C., Tran, S.C., Most, S.B., Le Pelley, M.E., 2015. Cognitive control and counterproductive oculomotor capture by reward-related stimuli. Vis. Cogn. 23, 41–66.

Pearson, D., Osborn, R., Whitford, T.J., Failing, M., Theeuwes, J., Le Pelley, M.E., 2016. Value-modulated oculomotor capture by task-irrelevant stimuli is a consequence of early competition on the saccade map. Atten. Percept. Psychophys. 78, 2226–2240.

Pearson, D., Watson, P., Cheng, P., Le Pelley, M.E., 2020. Overt attentional capture by reward-related stimuli overcomes inhibitory suppression. J. Exp. Psychol. Hum. Percept. Perform. 46, 489–501.

Peck, C.J., Salzman, C.D., 2014. Amygdala neural activity reflects spatial attention towards stimuli promising reward or threatening punishment. Elife 3, e04478.

Peck, C.J., Jangraw, D.C., Suzuki, M., Efem, R., Gottlieb, J., 2009. Reward modulates attention independently of action value in posterior parietal cortex. J. Neurosci. 29, 11182–11191.

Pessoa, L., 2009. How do emotion and motivation direct executive control? Trends Cogn. Sci. 13, 160–166.

Pessoa, L., Engelmann, J.B., 2010. Embedding reward signals into perception and cognition. Front. Neurosci. 4 (17), 1–8.

Peterson, M.S., Kramer, A.F., 2001. Attentional guidance of the eyes by contextual information and abrupt onsets. Percept. Psychophys. 63, 1239–1249.

Pollmann, S., Estocinova, J., Sommer, S., Chelazzi, L., Zinke, W., 2016. Neural structures involved in visual search guidance by reward-enhanced contextual cueing of the target location. NeuroImage 124, 887–897.

Pomerantz, J.R., Sager, L.C., Stoever, R.J., 1977. Perception of wholes and of their component parts: some configural superiority effects. J. Exp. Psychol. Hum. Percept. Perform. 3, 422–435.

Pool, E., Brosch, T., Delplanque, S., Sander, D., 2014. Where is the chocolate? Rapid spatial orienting toward stimuli associated with primary reward. Cognition 130, 348–359.

Pool, E., Brosch, T., Delplanque, S., Sander, D., 2016. Attentional bias for positive emotional stimuli: a meta-analytic investigation. Psychol. Bull. 142, 79–106.

Posner, M.I., 1980. Orienting of attention. Q. J. Exp. Psychol. 32, 3–25.

Preston, A.R., Gabrieli, J.D.E., 2008. Dissociation between explicit memory and configural memory in the human medial temporal lobe. Cereb. Cortex 18, 2192–2207.

Qi, S., Zeng, Q., Ding, C., Li, H., 2013. Neural correlates of reward-driven attentional capture in visual search. Brain Res. 1532, 32–43.

Qu, Z., Hillyard, S.A., Ding, Y., 2017. Perceptual learning induces persistent attentional capture by nonsalient shapes. Cereb. Cortex 27, 1512–1523.

Rajsic, J., Perera, H., Pratt, J., 2017. Learned value and object perception: accelerated perception or biased decisions? Atten. Percept. Psychophys. 79, 603–613.

Ramey, M.M., Yonelinas, A.P., Henderson, J.M., 2019. Conscious and unconscious memory differentially impact attention: eye movements, visual search, and recognition processes. Cognition 185, 71–82.

Raymond, J.E., O'Brien, J.L., 2009. Selective visual attention and motivation: the consequences of value learning in an attentional blink task. Psychol. Sci. 20, 981–988.

Reinhart, R.M.G., Woodman, G.F., 2015. Enhancing long-term memory with stimulation tunes visual attention in one trial. Proc. Natl. Acad. Sci. U. S. A. 112, 625–630.

Retell, J.D., Venini, D., Becker, S.I., 2015. Oculomotor capture by new and unannounced color singletons during visual search. Atten. Percept. Psychophys. 77, 1529–1543.

Reynolds, J.H., Chelazzi, L., Desimone, R., 1999. Competitive mechanisms subserve attention in macaque area V4. J. Neurosci. 19, 1736–1753.

Rimmele, J., Jolsvai, H., Sussman, E., 2011. Auditory target detection is affected by implicit temporal and spatial expectations. J. Cogn. Neurosci. 23, 1136–1147.

Roelfsema, P.R., van Ooyen, A., Watanabe, T., 2010. Perceptual learning rules based on reinforcers and attention. Trends Cogn. Sci. 14, 64–71.

Roper, Z.J.J., Vecera, S.P., 2016. Funny money: the attentional role of monetary feedback detached from expected value. Atten. Percept. Psychophys. 78, 2199–2212.

Roper, Z.J., Vecera, S.P., Vaidya, J.G., 2014. Value-driven attentional capture in adolescence. Psychol. Sci. 25, 1987–1993.

Rorden, C., Kristjansson, A., Revill, K.P., Saevarsson, S., 2011. Neural correlates of inter-trial priming and role-reversal in visual search. Front. Hum. Neurosci. 5, 151.

Rosero, M.A., Winkelmann, T., Pohlack, S., Cavalli, J., Nees, F., Flor, H., 2019. Memory-guided attention: bilateral hippocampal volume positively predicts implicit contextual learning. Brain Struct. Funct. 224, 1999–2008.

Rutherford, H.J., O'Brien, J.L., Raymond, J.E., 2010. Value associations of irrelevant stimuli modify rapid visual orienting. Psychon. Bull. Rev. 17, 536–542.

Sali, A.W., Anderson, B.A., Yantis, S., 2013. Reinforcement learning modulates the stability of cognitive control settings for object selection. Front. Integr. Neurosci. 7 (95).

Sali, A.W., Anderson, B.A., Yantis, S., 2014. The role of reward prediction in the control of attention. J. Exp. Psychol. Hum. Percept. Perform. 40, 1654–1664.

Sali, A.W., Anderson, B.A., Yantis, S., 2015. Learned states of preparatory attentional control. J. Exp. Psychol. Learn. Mem. Cogn. 41, 1790–1805.

Sali, A.W., Anderson, B.A., Yantis, S., Mostofsky, S.H., Rosch, K.S., 2018. Reduced value-driven attentional capture among children with ADHD compared to typically developing controls. J. Abnorm. Child Psychol. 46, 1187–1200.

Salovich, N.A., Remington, R.W., Jiang, Y.V., 2018. Acquisition of habitual visual attention and transfer to related tasks. Psychon. Bull. Rev. 25, 1052–1058.

San Martin, R., Appelbaum, L.G., Huettel, S.A., Woldorff, M.G., 2016. Cortical brain activity reflecting attentional biasing toward reward-predicting cues covaries with economic decision-making performance. Cereb. Cortex 26, 1–11.

Sanz, L.R.D., Vuilleumier, P., Bourgeois, A., 2018. Cross-modal integration during value-driven attentional capture. Neuropsychologia 120, 105–112.

Sasaki, Y., Nanez, J.E., Watanabe, T., 2010. Advances in visual perceptual learning and plasticity. Nat. Rev. Neurosci. 11, 53–60.

Sauter, M., Liesefeld, H.R., Müller, H.J., 2019. Learning to suppress salient distractors in the target dimension: region-based inhibition is persistent and transfers to distractors in a nontarget dimension. J. Exp. Psychol. Learn. Mem. Cogn. 45, 2080–2097.

Schmidt, L.J., Belopolsky, A.V., Theeuwes, J., 2015a. Attentional capture by signals of threat. Cogn. Emot. 29, 687–694.

Schmidt, L.J., Belopolsky, A.V., Theeuwes, J., 2015b. Potential threat attracts attention and interferes with voluntary saccades. Emotion 15, 329–338.

Schmidt, L.J., Belopolsky, A.V., Theeuwes, J., 2017. The time course of attentional bias to cues of threat and safety. Cogn. Emot. 31, 845–857.

Schoups, A., Vogels, R., Qian, N., Orban, G., 2001. Practising orientation identification improves orientation coding in V1 neurons. Nature 412, 549–553.

Schultz, W., Dayan, P., Montague, P.R., 1997. A neural substrate of prediction and reward. Science 275, 1593–1599.

Seger, C.A., 2013. The visual corticostriatal loop through the tail of the caudate: circuitry and function. Front. Syst. Neurosci. 7 (104).

Seitz, A., Watanabe, T., 2005. A unified model for perceptual learning. Trends Cogn. Sci. 9, 329–334.

Seitz, A., Lefebvre, C., Watanabe, T., Jolicoeur, P., 2005. Requirement for high-level processing in subliminal learning. Curr. Biol. 15, R753–R755.

Seitz, A.R., Kim, D., Watanabe, T., 2009. Rewards evoke learning of unconsciously processed visual stimuli in adult humans. Neuron 61, 700–707.

Serences, J.T., 2008. Value-based modulations in human visual cortex. Neuron 60, 1169–1181.

Serences, J.T., Saproo, S., 2010. Population response profiles in early visual cortex are biased in favor of more valuable stimuli. J. Neurophysiol. 104, 76–87.

Serences, J.T., Yantis, S., 2006. Selective visual attention and perceptual coherence. Trends Cogn. Sci. 10, 38–45.

Serences, J.T., Shomstein, S., Leber, A.B., Golay, X., Egeth, H.E., Yantis, S., 2005. Coordination of voluntary and stimulus-driven attentional control in human cortex. Psychol. Sci. 16, 114–122.

Sha, L.Z., Jiang, Y.V., 2016. Components of reward-driven attentional capture. Atten. Percept. Psychophys. 78, 403–414.

Sharifian, F., Contier, C., Preuschhof, C., Pollmann, S., 2017. Reward modulation of contextual cueing: repeated context overshadows repeated target location. Atten. Percept. Psychophys. 79, 1871–1877.

Shen, D., Alain, C., 2012. Implicit temporal expectation attenuates auditory attentional blink. PLoS One 7, e36031.

Shiffrin, R.M., Schneider, W., 1977. Controlled and automatic human information processing II: perceptual learning, automatic attending, and general theory. Psychol. Rev. 84, 127–190.

Shiu, L.P., Pashler, H., 1992. Improvement in line orientation discrimination is retinally local but dependent on cognitive set. Percept. Psychophys. 52, 582–588.

Shuler, M.G., Bear, M.F., 2006. Reward timing in the primary visual cortex. Science 311, 1606–1609.

Shurygina, O., Kristjánsson, Á., Tudge, L., Chetverikov, A., 2019. Expectations and perceptual priming in a visual search task: evidence from eye movements and behavior. J. Exp. Psychol. Hum. Percept. Perform. 45, 489–499.

Sisk, C.A., Remington, R.W., Jiang, Y.V., 2020. A spatial bias toward highly rewarded locations is associated with awareness. J. Exp. Psychol. Learn. Mem. Cogn. 46, 669–683.

Small, D.M., Gitelman, D., Simmons, K., Bloise, S.M., Parrish, T., Mesulam, M.M., 2005. Monetary incentives enhance processing in brain regions mediating top-down control of attention. Cereb. Cortex 15, 1855–1865.

Smith, S.D., Most, S.B., Newsome, L.A., Zald, D.H., 2006. An "emotional blink" of attention elicited by aversively conditioned stimuli. Emotion 6, 523–527.

Smyth, A.C., Shanks, D.R., 2008. Awareness in contextual cuing with extended and concurrent explicit tests. Mem. Cognit. 36, 403–415.

Sokolov, E.N., 1975. The neuronal mechanisms of the orienting reflex. In: Sokolov, E.N., Vinogradova, O.S. (Eds.), Neuronal Mechanisms of the Orienting Reflex. Erlbaum, Hillsdale, NJ, pp. 217–235.

Sommer, S., Pollmann, S., 2016. Putamen activation represents an intrinsic positive prediction error signal for visual search in repeated configurations. Open Neuroimag. J. 10, 126–138.

Sommer, M.A., Wurtz, R.H., 2001. Frontal eye field sends delay activity related to movement, memory, and vision to the superior colliculus. J. Neurophysiol. 85, 1673–1685.

Sommer, M.A., Wurtz, R.H., 2004. What the brain stem tells the frontal cortex. I. Oculomotor signals sent from superior colliculus to frontal eye field via mediodorsal thalamus. J. Neurophysiol. 91, 1381–1402.

Sperling, G., 1960. The information available in brief visual presentations. Psychol. Monogr. Gen. Appl. 74, 1–28.

Staib, M., Bach, D.R., 2018. Stimulus-invariant auditory cortex threat encoding during fear conditioning with simple and complex sounds. NeuroImage 166, 276–284.

Staib, M., Abivardi, A., Bach, D.R., 2020. Primary auditory cortex representation of fear-conditioned musical sounds. Hum. Brain Mapp. 41, 882–891.

Stankevich, B.A., Geng, J.J., 2014. Reward associations and spatial probabilities produce additive effects on attentional selection. Atten. Percept. Psychophys. 76, 2315–2325.

Stankevich, B.A., Geng, J.J., 2015. The modulation of reward priority by top-down knowledge. Vis. Cogn. 23, 206–228.

Stilwell, B.T., Bahle, B., Vecera, S.P., 2019. Feature-based statistical regularities of distractors modulate attentional capture. J. Exp. Psychol. Hum. Percept. Perform. 45, 419–433.

Stolarova, M., Keil, A., Moratti, S., 2006. Modulation of the C1 visual event-related component by conditioned stimuli: evidence for sensory plasticity in early affective perception. Cereb. Cortex 16, 876–887.

Suh, J., Abrams, R.A., 2020. Approach and avoidance movements modulate value-driven attentional capture. J. Exp. Psychol. Hum. Percept. Perform. 46, 105–123.

Sui, J., He, X., Humphreys, G.W., 2012. Perceptual effects of social salience: evidence from self-prioritization effects on perceptual matching. J. Exp. Psychol. Hum. Percept. Perform. 38, 1105–1117.

Sutherland, M.R., Mather, M., 2012. Negative arousal amplifies the effects of saliency in short-term memory. Emotion 12, 1367–1372.

Sutherland, M.R., Mather, M., 2015. Negative arousal increases the effects of stimulus salience in older adults. Exp. Aging Res. 41, 259–271.

Tacikowski, P., Nowicka, A., 2010. Allocation of attention to self-name and self-face: an ERP study. Biol. Psychol. 84, 318–324.

Talcott, T.N., Gaspelin, N., 2020. Prior target locations attract overt attention during search. Cognition 201, 104282.

Telling, A.L., Kumar, S., Meyer, A.S., Humphreys, G., 2010. Electrophysiological evidence of semantic interference in visual search. J. Cogn. Neurosci. 22, 2212–2225.

Theeuwes, J., 1992. Perceptual selectivity for color and form. Percept. Psychophys. 51, 599–606.

Theeuwes, J., 1994. Stimulus-driven capture and attentional set: selective search for color and visual abrupt onsets. J. Exp. Psychol. Hum. Percept. Perform. 20, 799–806.

Theeuwes, J., 2010. Top-down and bottom-up control of visual selection. Acta Psychol. 135, 77–99.

Theeuwes, J., 2013. Feature-based attention: it is all bottom-up priming. Philos. Trans. R. Soc. B Biol. Sci. 368, 20130055.

Theeuwes, J., 2018. Visual selection: usually fast and automatic; seldom slow and volitional. J. Cogn. 1, 29.

Theeuwes, J., 2019. Goal-driven, stimulus-driven, and history-driven selection. Curr. Opin. Psychol. 29, 97–101.

Theeuwes, J., Belopolsky, A.V., 2012. Reward grabs the eye: oculomotor capture by rewarding stimuli. Vision Res. 74, 80–85.

Thigpen, N.N., Bartsch, F., Keil, A., 2017. The malleability of emotional perception: short-term plasticity in retinotopic neurons accompanies the formation of perceptual biases to threat. J. Exp. Psychol. Gen. 146, 464–471.

Tibboel, H., Liefooghe, B., 2020. Attention for future reward. Psychol. Res. 84, 706–712.

Todd, R.M., Manaligod, M.G.M., 2018. Implicit guidance of attention: the priority state space framework. Cortex 102, 121–138.

Travis, S.L., Mattingley, J.B., Dux, P.E., 2013. On the role of working memory in spatial contextual cueing. J. Exp. Psychol. Learn. Mem. Cogn. 39, 208–219.

Treisman, A., 1992. Perceiving and re-perceiving objects. Am. Psychol. 47, 862–875.

Treisman, A.M., Gelade, G., 1980. A feature-integration theory of attention. Cogn. Psychol. 12, 97–136.

Tseng, Y.C., Lleras, A., 2013. Rewarding context accelerates implicit guidance in visual search. Atten. Percept. Psychophys. 75, 287–298.

Vadillo, M.A., Konstantinidis, E., Shanks, D.R., 2016. Underpowered samples, false negatives, and unconscious learning. Psychon. Bull. Rev. 23, 87–102.

Vadillo, M.A., Linssen, D., Orgaz, C., Parsons, S., Shanks, D.R., 2020. Unconscious or underpowered? Probabilistic cuing of visual attention. J. Exp. Psychol. Gen. 149, 160–181.

van Asselen, M., Sampaio, J., Pina, A., Castelo-Branco, M., 2011. Object based implicit contextual learning: a study of eye movements. Atten. Percept. Psychophys. 73, 297–302.

Van Damme, S., Crombez, G., Notebaert, L., 2008. Attentional bias to threat: a perceptual accuracy approach. Emotion 8, 820–827.

van Koningsbruggen, M.G., Ficarella, S.C., Battelli, L., Hickey, C., 2016. Transcranial random-noise stimulation of visual cortex potentiates value-driven attentional capture. Soc. Cogn. Affect. Neurosci. 11, 1481–1488.

van Moorselaar, D., Slagter, H.A., 2019. Learning what is irrelevant or relevant: expectations facilitate distractor inhibition and target facilitation through distinct neural mechanisms. J. Neurosci. 35, 6953–6967.

Vankov, A., Hervé-Minvielle, A., Sara, S.J., 1995. Response to novelty and its rapid habituation in locus coeruleus neurons of the freely exploring rat. Eur. J. Neurosci. 7, 1180–1187.

Vatterott, D.B., Vecera, S.P., 2012. Experience-dependent attentional tuning of distractor rejection. Psychon. Bull. Rev. 19, 871–878.

Vo, M.L., Wolfe, J.M., 2013. Differential ERP signatures elicited by semantic and syntactic processing in scenes. Psychol. Sci. 24, 1816–1823.

Vromen, J.M.G., Lipp, O.V., Remington, R.W., Becker, S.I., 2016. Threat captures attention, but not automatically: top-down goals modulate attentional orienting to threat distractors. Atten. Percept. Psychophys. 78, 2266–2279.

Vuilleumier, P., 2005. How brains beware: neural mechanisms of emotional attention. Trends Cogn. Sci. 9, 585–594.

Wade, A., Augath, M., Logothetis, N., Wandell, B., 2008. fMRI measurements of color in macaque and human. J. Vis. 8 (10), 1–19, 6.

Walsh, V., Le Mare, C., Blaimire, A., Cowey, A., 2000. Normal discrimination performance accompanied by priming deficits in monkeys with V4 or TEO lesions. Neuroreport 11, 1459–1462.

Wang, B., Theeuwes, J., 2018a. Statistical regularities modulate attentional capture. J. Exp. Psychol. Hum. Percept. Perform. 44, 13–17.

Wang, B., Theeuwes, J., 2018b. How to inhibit a distractor location? Statistical learning versus active, top-down suppression. Atten. Percept. Psychophys. 80, 860–870.

Wang, B., Theeuwes, J., 2018c. Statistical regularities modulate attentional capture independent of search strategy. Atten. Percept. Psychophys. 80, 1763–1774.

Wang, D., Kristjansson, A., Nakayama, K., 2005. Efficient visual search without top-down or bottom-up guidance. Percept. Psychophys. 67, 239–253.

Wang, L., Yu, H., Zhou, X., 2013. Interaction between value and perceptual salience in value-driven attentional capture. J. Vis. 13 (3:5), 1–13.

Wang, L., Duan, Y., Theeuwes, J., Zhou, X., 2014. Reward breaks through the inhibitory region around attentional focus. J. Vis. 14 (12), 1–7, 2.

Wang, L., Li, S., Zhou, X., Theeuwes, J., 2015a. Stimuli that signal the availability of reward break into attentional focus. Vision Res. 144, 20–28.

Wang, L., Yu, H., Hu, J., Theeuwes, J., Gong, X., Xiang, Y., Jiang, C., Zhou, X., 2015b. Reward breaks through center-surround inhibition via Anterior Insula. Hum. Brain Mapp. 36, 5233–5251.

Wang, B., Samara, I., Theeuwes, J., 2019a. Statistical regularities bias overt attention. Atten. Percept. Psychophys. 81, 1813–1821.

Wang, B., van Driel, J., Ort, E., Theeuwes, J., 2019b. Anticipatory distractor suppression elicited by statistical regularities in visual search. J. Cogn. Neurosci. 31, 1535–1548.

Watson, P., Pearson, D., Chow, M., Theeuwes, J., Wiers, R.W., Most, S.B., Le Pelley, M.E., 2019a. Capture and control: working memory modulates attentional capture by reward-related stimuli. Psychol. Sci. 30, 1174–1185.

Watson, P., Pearson, D., Most, S.B., Theeuwes, J., Wiers, R.W., Le Pelley, M.E., 2019b. Attentional capture by Pavlovian reward-signalling distractors in visual search persists when rewards are removed. PLoS One 14, e0226284.

Watson, P., Pearson, D., Theeuwes, J., Most, S.B., Le Pelley, M.E., 2020. Delayed disengagement of attention from distractors signalling reward. Cognition 195, 104125.

Wentura, D., Muller, P., Rothermund, K., 2014. Attentional capture by evaluative stimuli: gain- and loss-connoting colors boost the additional-singleton effect. Psychon. Bull. Rev. 21, 701–707.

Wittmann, B.C., Daw, N.D., Seymour, B., Dolan, R.J., 2008. Striatal activity underlies novelty-based choice in humans. Neuron 58, 967–973.

Wolfe, J.M., 1994. Guided search 2.0: a revised model of visual search. Psychon. Bull. Rev. 1, 202–238.

Wolfe, J.M., 2020. Visual search: how do we find what we are looking for? Annu. Rev. Vis. Sci. 6 https://doi.org/10.1146/annurev-vision-091718-015048 online first.

Wolfe, J.M., Horowitz, T.S., 2017. Five factors that guide attention in visual search. Nat. Hum. Behav. 1, 0058.

Wolfe, J.M., Cave, K.R., Franzel, S.L., 1989. Guided search: an alternative to the feature integration model for visual search. J. Exp. Psychol. Hum. Percept. Perform. 15, 419–433.

Won, B.-Y., Leber, A.B., 2016. How do magnitude and frequency of monetary reward guide visual search. Atten. Percept. Psychophys. 78, 1221–1231.

Wood, N., Cowan, N., 1995. The cocktail party phenomenon revisited: how frequent are the attention shifts to one's own name in an irrelevant auditory channel? J. Exp. Psychol. Learn. Mem. Cogn. 21, 255–260.

Woodman, G.F., Arita, J.T., 2011. Direct electrophysiological measurement of attentional templates in visual working memory. Psychol. Sci. 22, 212–215.

Woodman, G.F., Carlisle, N.B., Reinhart, R.M.G., 2013. Where do we store the memory representations that control attention? J. Vis. 13 (1), 1–17, 1.

Yamamoto, S., Monosov, I.E., Yasuda, M., Hikosaka, O., 2012. What and where information in the caudate tail guides saccades to visual objects. J. Neurosci. 32, 11005–11016.

Yamamoto, S., Kim, H.F., Hikosaka, O., 2013. Reward value-contingent changes in visual responses in the primate caudate tail associated with a visuomotor skill. J. Neurosci. 33, 11227–11238.

Yantis, S., Johnston, J.C., 1990. On the locus of visual selection: evidence from focused attention tasks. J. Exp. Psychol. Hum. Percept. Perform. 16, 135–149.

Yantis, S., Jonides, J., 1984. Abrupt visual onsets and selective attention: evidence from visual search. J. Exp. Psychol. Hum. Percept. Perform. 10, 350–374.

Yantis, S., Anderson, B.A., Wampler, E.K., Laurent, P.A., 2012. Reward and attentional control in visual search. In: Dodd, M.D., Flowers, J.H. (Eds.), Nebraska Symposium on Motivation (Vol. 59), The Influence of Attention, Learning, and Motivation on Visual Search. Lincoln, NE: University of Nebraska Press.

Yu, R.Q., Zhao, J., 2015. The persistence of the attentional bias to regularities in a changing environment. Atten. Percept. Psychophys. 77, 2217–2228.

Zhao, J., Luo, Y., 2017. Statistical regularities guide the spatial scale of attention. Atten. Percept. Psychophys. 79, 24–30.

Zhao, J., Al-Aidroos, N., Turk-Browne, N.B., 2013. Attention is spontaneously biased towards regularities. Psychol. Sci. 24, 667–677.

Zimmermann, J.F., Moscovitch, M., Alain, C., 2017. Long-term memory biases auditory spatial attention. J. Exp. Psychol. Learn. Mem. Cogn. 43, 1602–1615.

Zinchenko, A., Conci, M., Müller, H.J., Geyer, T., 2018. Predictive visual search: role of environmental regularities in the learning of context cues. Atten. Percept. Psychophys. 80, 1096–1109.

Zink, C.F., Pagnoni, G., Martin, M.E., Dhamala, M., Berns, G.S., 2003. Human striatal response to salient nonrewarding stimuli. J. Neurosci. 23, 8092–8097.