Skilled guidance[1]

Abstract: Skilled action typically requires that individuals guide their activities toward some goal. In skilled action, individuals do so excellently. We do not understand well what this capacity to guide consists in. In this paper I provide a case study of how individuals shift visual attention. Their capacity to guide visual attention toward some goal (partly) consists in an empirically discovered sub-system – the executive system. I argue that we can explain how individuals guide by appealing to the operation of this sub-system. Understanding skill and skilled action will therefore require appreciating the role of the executive system.

1 Skilled action and individuals' guidance

In central exercises of skilled action, individuals direct their activities toward some goal – they guide their activities.[2] Such actions are manifestations of skill if, and to the extent that, they exhibit an individual's excellence at so directing her activities. It is this excellence that distinguishes skill and skilled action from exercises of a mere ability to act. These assumptions are central to theorizing about skill since at least Aristotle.[3] They pervade recent thinking about skill.[4] They are starting points for what follows.[5]

Suppose that a macaque searches some bushes for raspberries. He actively shifts his visual attention across the foliage. His attention-shifting activity is directed toward the goal of finding berries of some specific color and shape. The monkey is skilled if, and to the extent that, he exhibits excellence at searching for berries. He may have contrived a particularly effective search strategy. Or he may have learnt to effectively suppress distractors that might otherwise interfere with his search. In either way, the monkey

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1 [redacted]

2 The notion of guidance derives from Frankfurt (1978). [redacted]

3 *Et.Nic.*

4 Fridland 2014, 2019; Ryle 1949; Stanley & Williamson 2001; Noe 2005; Shepherd 2019; Pavese 2018

5 For an argument that all skilled action is goal-directed, see Fridland 2019, 1-5. She rightly points out that goal-direction is compatible with an action's being automatic in several standard senses.

manifests skill in acting: he guides his activities toward that goal, and he excels at so guiding.

Insofar as individuals' activities in skilled action are guided toward a goal, they are plausibly subject to some form of control.[6] Not surprisingly, then, much of the literature on skilled action revolves around different kinds of control-structures and their role in manifesting skill.

Contributors have asked: what role do (practical) reason and knowledge play in skilled action?[7] How do different kinds of intention – distal and proximal, strategic, and practical – control skilled action?[8] What role do motor control-structures, such as the motor system, or motor representations, play?[9] Does, can, or must skilled actions involve some form of attention?[10] How about different forms of memory?[11] Is it a mark of skilled action that it occurs without consciousness?[12] And does all skilled action rely on some form of learning?[13] What are these different control-structures? What, if any, role do they play in skilled action? And how do different control-structures interact, integrate, or interface?[14]

These are important questions in their own right. My earlier claims about guidance in skilled action do not prejudge them. But the questions have special interest, I believe, precisely *because* they bear on how individuals guide their skilled actions. We want to know, for instance, whether my conscious intention controls fine-tuning of motor processes, *because* we want to know whether I guide these aspects of skill. We want to know whether different control-structures play a role in skilled action, *because* we are interested in how an individual guides her action through their operation. We want to

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6 Some philosophers maintain that they must be controlled, because they are actions. Maybe all action requires control over the act's execution. (Shepherd 2014) I leave this point open.
7 Stanley & Williamson 2001; Fridland 2014; Pavese 2018
8 Pacherie 2006, 2008; Fridland 2019
9 Stanley & Williamson 2001; Pacherie 2006, 2008; Fridland 2014; Butterfill & Sinigaglia 2014; Shepherd 2019
10 Wu 2013; Mylopoulos & Pacherie 2017; Christensen et al. 2016; Montero 2016; Buehler 2019
11 Christensen et al. 2019
12 Papineau 2013; Shepherd 2015
13 Stanley & Krakauer 2013
14 Butterfill & Sinigaglia 2014; Mylopoulos & Pacherie 2017; Shepherd 2019; Fridland 2019. Another strand in the literature focuses on whether skill is intelligent or whether it is automatic. (Stanley & Williamson 2001; Fridland 2017; Christensen et al. 2016; Christensen 2019) What I say about guidance is compatible with the idea that some aspects of skilled action are automatic in some sense. I do, however, reject the notion that skilled action is ballistic, reflex-like, and entirely inflexible.

know how different capacities integrate, *because* we are interested in why and how their interaction constitutes the individual's control, or are aspects of her agency.

We need to ask, then, under what conditions does the operation of these control-structures during the execution of some action constitute the individual's control? Under what conditions is it *the individual herself that guides* her activities toward her goal? Only if we have answered *this* question can we attribute manifestations of skill to the individual. Only then can we systematically ask in what sense the individual herself exhibits excellence in executing some action. Only then can she be the locus of responsibility, praise, and blame. Nevertheless, this issue has not yet been explicitly discussed at any length.[15]

It is this question about individuals' guidance that I want to address in this paper. I shall attempt to answer the question for one particular visual skill: the active, goal-directed orientation of visual attention, especially in visual search. I will show how we can harness empirical research for this purpose. For actual primate individuals, the capacity to guide visual attention partly consists in an empirically discovered psychological sub-system. I will argue that

> *Individuals' guidance*
> An individual's guidance of her attention-shifts toward some goal partly consists in her executive system's regulating processing across pertinent sub-systems, for attaining that goal.

The executive system's regulation not merely constitutes a condition on individuals' guidance of their visual attention-shifts; appealing to this condition we can explain both how attention-shifts are directed toward the individual's goal, and why some direction is attributable to the whole individual.[16] We can thus explain whole-individual

[15] This is not to say that contributors are insensitive to this issue. See Pacherie 2006, 2, 6, 15; 2008, 14. Fridland 2017, 4, 20; 2019, 3ff., 12. Shepherd 2019 rightly points out that, if we do not explain how *individuals* guide their action through the operation of, e.g., motor control structures, we "risk commitment to something like two centers of agency present in the skilled [agent]. … we seem to need an explanation of how these systems manage to interface and coordinate rather than to compete for the control of action." (2019, 288) The control must be the *individual's*.

[16] Christensen et al. 2016 have independently drawn a connection between skilled action and executive function. They are not concerned with goal-directed guidance in my minimal sense, but with the contribution of higher (conscious) cognition, especially conscious attention, to aspects of skilled action. (*ibid*., 40, 45/6, 61/2) While I think of the executive functions as competencies at the level of sub-systems alone, they seem to think of them as individual-level capacities. (See below,

activity – such as goal-directed action – by appeal to the operation of the individual's sub-systems.

The case is of intrinsic interest. This visual skill plays crucial epistemic roles. It is central to questions about the control of skilled bodily action, and many other issues. My aim here, however, is to address questions about individuals' guidance. I believe it can be argued that executive regulation constitutes an individuals' capacity to guide across different kinds of action. The argument in this paper may serve as a blueprint for finding conditions on such guidance across different kinds of action.

In section 2 I explain how visual attention shifts. I show that the executive system regulates attention-shifts so as to direct them toward attaining individuals' goals. I argue that executive regulation constitutes a condition on individuals' exercise of their capacity to guide. In section 3 I argue for the explanatory condition: that executive regulation not merely conditions but actually *explains* this capacity and its exercises. In section 4 I conclude by tying questions about individuals' guidance back to skill and skilled action.

2 Guiding visual attention

In this section I argue that we can distinguish between guided and non-guided attention-shifts at the level of psychological sub-systems. More specifically, I will argue for the following

> *Actual condition*
> If an individual guides her attention-shifts toward some goal, then her executive system regulates processing across pertinent sub-systems for attaining that goal.

I will argue for the actual condition after first motivating and rejecting a preliminary proposal as to how to make this distinction.

2.1 Exogenous and Endogenous Shifts: A Preliminary Proposal

section 3.) While I emphasize functional aspects of agency, in particular, guidance, that the executive functions explain, they focus on explaining the experience of skilled action. But even though (i) their argumentative goal, (ii) their conception of an executive system, and (iii) the empirical data and philosophical arguments they provide differ from mine, I believe that there are more points of agreement than disagreement between the two contributions.

The following cases illustrate the distinction between visual attention-shifts that individuals guide, and those that are not thus guided.

Suppose that a macaque intends to observe her infant. She shifts her attention to the baby and *focuses attention* there. Or remember the macaque *searching* for raspberries. He systematically guides his visual attention from one location to the next until he finds the berries. These individuals guide their shifts of attention. In contrast, suppose that the macaque is being groomed. His eyes and attention shift without any immediate specific purpose. His attentional system is in a state of *default activity*, similar to the respiratory system's activity during breathing. Or imagine that a bright, spider-shaped object abruptly appears in the periphery of the monkey's field of view. The object's appearance *captures* her attention. These individuals do not guide their attention-shifts in either case.

What distinguishes these different kinds of shifts at the level of psychological systems? According to psychology, the system for orienting attention has an exogenous and an endogenous component. The latter is often explicitly associated with active, or voluntary attention-shifts.[17] I will now first motivate a preliminary proposal for distinguishing guided and non-guided shifts in terms of these two systems. Next, I criticize and refine this proposal.

I begin by laying out some widely shared assumptions about the attentional system. Michael Posner first provided empirical evidence for the existence of an endogenous and an exogenous system for orienting attention.[18] Posner instructed individuals to orient attention toward target-location in a display. Subjects first focused attention at a fixation point on an otherwise empty screen. Next, they saw a display with a cue for target-location. The final display presented the target. Posner tested how different kinds of cue would affect the efficiency with which subjects performed the task.

Figure 1

[17] Carrasco 2011
[18] Posner 1980

Posner varied both type of cue and cue-validity. All cues purported to indicate the future location of the target. Invalid cues correctly indicated a location in only 20% of the trials. Valid cues did so in 80% of the trials. Symbolic cues appeared at fixation point. They were, for example, arrows pointing at the future location of the target. Direct cues might be small dots that briefly appeared at the purported future location of the target. Posner found that individuals shifted attention to the target more rapidly on the basis of valid cues. Their performance slowed down when cues were invalid. In these latter cases, the location indicated by the misleading cues attracted their attention. Posner also found that when symbolic cues were unreliable, individuals ceased to rely on them. The invalidity of direct cues did not lead to improved performance, even after a series of trials. Individuals apparently could not ignore flashing dots, even when explicitly instructed to do so.[19]

Posner had thus found evidence for two distinct systems for orienting attention, carrying different signatures. The endogenous system carries out symbolic shifts, direct cues cause shifts through activity of the exogenous system. The two systems differ with respect to the stimuli that they respond to.[20] They also differ with respect to how *accessed* and *penetrated* they are.[21] Both sets of properties further support the idea that the endogenous system might be responsible for active attention-shifts.

The exogenous system responds to stimuli that are physically salient – roughly, these stimuli stand out from their environment, such as green objects stand out from a predominantly red background. The system also responds to stimuli, detection of which was of special evolutionary importance, e.g. shapes of predators or mates. The endogenous system's activity, on the other hand, is not restricted to any specific type of stimulus.

The endogenous system's states and events often are, or are *accessed* by, the individual's central states and events: its states and events include central states such as intentions, beliefs, expectations, or goals. And they are often available for higher, non-

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[19] Jonides 1981

[20] Wright. & Ward 2008, 24; Carrasco. 2011, 1488

[21] A representational state or event with input from different modalities is intermodal. Modular processes are fast, automatic, driven by a very limited range of inputs, relatively encapsulated, and inaccessible to consciousness. (Fodor1983, 47ff.)

modular and amodal processing such as decision-making and inference.[22] Individuals typically do not access activity, states, or events of the exogenous system in any of these ways. Many of its states and events are not accessible in principle.[23]

Similarly, states and events of the endogenous system are often *penetrated*: they are, or are under the influence of, the individual's current intentions, goals, beliefs, and so forth. Individuals' intentions not to rely on certain cues can determine where the endogenous system shifts attention. Central states and events have little effect on the activity of the exogenous system. Individuals' intention to ignore invalid direct cues has basically no impact on their negative influence on where attention shifts. The states and events of the exogenous system are typically not penetrated, often even in principle beyond central states' influence.[24]

A difference in the evolutionary function of the two systems partly explains these different signatures.[25] The exogenous system is phylogenetically older. It is a warning system that disrupts individuals' current behavior in the face of behaviorally highly relevant stimuli. It functions to rapidly detect and orient the individual towards highly salient stimuli, especially danger, mates, and food. This function explains why its operation is very difficult, sometimes impossible to suppress. The phylogenetically more recent endogenous system functions to support planned, goal-directed behavior. This system shifts attention when the individual needs to gather information about her environment, or for the control of individuals' intentional bodily actions.[26]

Both systems are grouped around a *priority map*. The priority map is a psychological state with a topographical representation of the visual scene as its content. The map assigns priority values to objects and locations in the scene. Locations and objects have priority *for* shifting attention to them. Attention shifts to the location with highest priority. Both the exogenous and endogenous systems generate assignments of priority on this map. When attention shifts exogenously, the exogenous system

[22] They are, or could become, rational-access conscious. (Block. 1995) Human individuals can often report being in those states or undergoing such events.
[23] Carrasco 2011; Giordano, McElree & Carrasco 2009
[24] *Ibid*.
[25] Carrasco 2011, 1488
[26] The endogenous and exogenous systems are not only behaviorally and functionally, but also anatomically distinct. (Corbetta & Shulman 2002; Shipp 2004; Gottlieb 2014)

determines the priority assignment on the map. The endogenous system determines priority values on the priority map for endogenous shifts.[27]

As I mentioned earlier, psychologists refer to exogenous (or reflexive, transient, bottom-up) shifts as passive or involuntary shifts. They often identify endogenous (or sustained, top-down) shifts with active or voluntary shifts.[28] This fact suggest the following:

> *Preliminary condition*
> If an individual guides her attention-shifts toward some goal, then her endogenous system drives these shifts alone.

Properties of the systems' operation support this proposal. *Exo*genous shifts appear typically to be driven by physical properties of the sensory stimulus alone. The source of these shifts hence seems external to the individual. By contrast, individuals' goals, intentions, and beliefs influence and effect *endo*genous shifts. These shifts' sources lie within the individual, in some sense. Furthermore, when individuals guide their activity, it is natural to assume that they should access their activity and the states informing the activity. These states and activities should be, or be penetrated by, the individuals' central states and events. Shifts by the endogenous system have these features. States and events of the exogenous system, however, are often inaccessible and not penetrated.

Research on the focusing of attention, capture of attention, and attentional default activity appears to confirm the proposal. A stimulus *captures* attention when it is of high physical saliency or behavioral relevance. When a stimulus captures attention, it often disrupts or overrides individuals' guidance. Theeuwes and others provided evidence that the exogenous system alone drives those shifts.[29] They explicitly informed subjects that the color of stimuli would be irrelevant to an orientation-task. Nevertheless, subjects

[27] Behavioral, brain, and computational studies converge in relying on such a map for understanding the activity of the exogenous and endogenous systems. See, for instance, Itti & Koch 2000; Zelinsky 2008; Najemnik & Geisler 2009. [redacted] In what follows, whenever I describe how different systems or states help shift attention, it should be understood that they do so by influencing priority assignments on the priority map.
[28] Carrasco 2011; Wright & Ward 2008
[29] Theeuwes 1991a; Theeuwes 1991. Cf. also Jonides 1981; Yantis & Jonides 1984; Yantis & Jonides 1990; Theeuwes 1992

could not avoid shifts to a salient color-distractor. Stimuli apparently capture attention when they surpass a saliency-threshold set by the exogenous system.[30] Such shifts seem insensitive to individuals' intentions and expectations. Individuals' current central states do not penetrate captured shifts. The states of the exogenous system that cause attentional capture are inaccessible to the individual. Shifts during capture are explained on the basis of principles governing the activity of this sub-system alone.[31]

When the attentional system is in its *default state,* specific saliency-based attentional routines determine where attention shifts.[32] In default mode, attention regularly and continuously shifts between relatively salient locations. The saliency of locations is registered and ranked in a master saliency map. This ranking then determines where attention shifts.[33] Individuals' beliefs, intentions, and goals do not penetrate a sequence of shifts in the default state. Individuals cannot access the states generating these attentional routines. Often they cannot even access how or even *whether* they shift attention. Such shifts are plausibly explained by principles governing the exogenous system alone.

When individuals *focus attention* at some specific location, finally, an endogenous factor – for example an intention to shift to that location – alone drives that shift.[34] Thus Theeuwes[35] also showed that, when a symbolic cue reliably indicated the location where a target would appear, individuals could shift attention to that location without being distracted by a dot flashing in a different location. They just had to be given sufficient time to orient attention to the target. The distractor does interfere with focusing of attention if it is flashed 200 ms after presentation of the symbolic cue. After 300 ms, however, the distractor no longer influences individuals' shift. In the latter instance, a symbolic cue determines where attention shifts. The processing of the cue is both

30 Wright & Ward 2008. The threshold depends on context.
31 Early research on capture assumed that a salient stimulus overrides the individuals' endogenous control under *all* circumstances. But attentional capture is not strongly automatic. Rather, capture is a function of context and intensity of the salient stimulus. (Lamy 2008; Yeh & Liao 2008; Folk, Ester & Troemel 2009; Lamy, Leber & Egeth 2012)
32 Pashler 2001; Bacon & Egeth 1994
33 Ullman 1996; Cavanagh, P., Labianca & Thornton 2001; Cavanagh 2005.
34 Wright & Ward 2008
35 Theeuwes 1991; Yantis & Jonides 1990

accessed and penetrated. In this case, then, we can explain where attention shifts by appeal to principles governing the endogenous system alone.

2.2 Interactions: Drawn Attention

The preliminary condition has two major shortcomings. One shortcoming is its inability to accommodate *interactions* between the endogenous and exogenous systems. The other is that the nature of the endogenous factors implementing individuals' guidance is *underspecified*. I discuss both shortcomings in turn.

According to the preliminary condition, when an individual guides her attention-shift, the endogenous system *alone* determines where attention shifts. Many shifts that the individual guides, however, result from the interaction of the endogenous and exogenous systems. Shifts during visual search, for example, *typically* involve the interaction of exogenous and endogenous systems.

Folk, Remington, and Johnston conducted a series of experiments showing that endogenous factors can to some extent shape the activity of the exogenous system.[36] They asked one group of individuals to locate an abruptly appearing letter. Of four possible locations in the search display, three were empty. In the fourth, the letter would appear. Another group of individuals located a color singleton target. In this set of trials, all four locations contained characters. Only the target stood out in color. The cue for *both* types of trial was an abrupt onset configuration, a set of small circles flashing around one of the possible locations.

Figure 2

Folk et al. found that valid cues shortened reaction times relative to the condition in which no cue was present. Invalid cues, however, increased reaction times *only* when the target was an onset. Search time exhibited no effect if cue and target did not share features. Abrupt onsets and singletons did not invariably attract attention. Rather, they

[36] Folk, Remington & Johnston 1992, 1035

sometimes configured the exogenous system to respond selectively to specific properties of stimuli that are relevant to the task at hand.[37]

In these experiments, an endogenous goal drives and constrains the individual's shifts. Her search goal configures the exogenous system to be sensitive to onset items. The exogenous system's influence on such endogenously driven shifts does not undermine the individual's guidance. Indeed, it *enhances* the individual's search. When a stimulus attracts attention, but does not fully override or interrupt an individual's guidance, I will say that attention is *drawn* by a stimulus.

We recognize individuals as guiding their attention not only in many cases where the operation of the exogenous enhances the individual's search, but also when it *interferes* with her search. Research on eye movements illustrates such interference. Individuals who know that a cue is invalid sometimes exhibit trajectories curved away from the stimulus.[38] These saccades suggest that the endogenous system counteracts a distractor's influence. The distractor increases reaction times, hence interferes with search, but does not capture attention. In other contexts, researchers found that saccade-trajectories exhibited curvature towards the distractor.[39] The saccade seemed to first aim for the distractor, then curve away from it, before eventually reaching the target. The distractor initially attracted attention, but the endogenous system eventually suppressed this attraction and carried attention towards the target. At no point did the individual cease to guide her attention-shift.

Attention is *drawn* when stimuli attract attention but do not override or disrupt the individual's guidance. In many cases, individuals guide their attention-shifts, even when these shifts result from the interaction of the endogenous and exogenous systems. The preliminary condition does not allow for such interaction. We must update the condition in light of the phenomenon of drawn attention.

The second shortcoming of the preliminary condition is that the relevant endogenous factor is underspecified. Psychology considers a wide range of factors to be 'endogenous.' Earlier, I mentioned intentions, beliefs, expectations, and goals, among others. The class of 'endogenous' factors discussed by psychologists is even larger. Not

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[37] *Ibid.*, 1041ff.
[38] Walker & McSorley 2008
[39] McPeek, Han & Keller 2003; Walker, McSorley & Haggard 2006

all these factors correlate with individuals' guidance. These factors, too, draw attention. Here are some of them.

Individuals can be *primed* to be more sensitive and react more readily to certain stimuli.[40] If an individual repeatedly searches for a green diamond, she will get faster at finding green diamonds. Once primed for green diamonds, the individual will find it more difficult to ignore green diamonds during subsequent searches – even if now she is looking for a red circle.

Associations of past *reward* with types of stimuli similarly affect individuals' performance on current search tasks.[41] If green diamonds, in the individual's past, were associated with some kind of reward – indicating a food source – the individual's attention-shifts will be more likely attracted by them, even if she is engaged in a search for a red circle.

Individuals store statistical information about *configurations* in visual scenes.[42] When a search target consistently appears at a certain distance and angle from, say, a heptagon of vertical bars, individuals more readily shift attention to a location at the same distance and angle from such a configuration. The memory for the configuration draws attention to the location.

Individuals store large amounts of information about *objects and scenes* in long-term memory.[43] These memories, too, influence how individuals shift attention. Suppose the individual is searching for a certain type of food. The individual finds herself in an environment where predators are likely to stalk her in lower branches of certain types of trees. The individual will be more likely to shift attention to the lower branches of those trees even if such shifts of attention interfere with her search for the food.

All these endogenous factors draw attention. Sometimes they enhance an individual's search; sometimes they interfere with it. The individual's guidance of the relevant attention-shifts does not plausibly consist in these factors' influence, despite the

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[40] Kristjansson & Campana 2010; Kristjansson & Nakayama 2003; Maljkovic & Nakayama 1994; Maljkovic & Nakayama 2000

[41] Anderson 2013; Anderson & Yantis 2013; Anderson, Laurent & Yantis 2011a/b; Anderson, Laurent & Yantis 2012

[42] Chun & Jiang 1998; Chun 2003; Chun & Turk-Browne 2008

[43] Bar 2004; Brady, Konkle, Alvarez & Oliva 2008; Hollingworth 2014; Oliva 2005; Torralba, Oliva, Castelhano & Henderson 2006; Brockmole, Castelhano & Henderson 2006; Brockmole & Henderson 2006a

fact that they are elements in the endogenous system. After all, their influence in many cases interferes with an individual's guidance – as when she is primed to orient attention toward the green diamond, even while she is guiding attention toward the red circle. Again, we must update the preliminary condition. Not all endogenous factors appropriately correlate with individuals' guidance. We need to specify the endogenous factor that does.[44]

2.3 Shifts Guided by the Individual

I will now present, explain, and provide empirical support for, a condition that correlates with individuals' guidance of attention-shifts and that accommodates drawn attention. In the next section I will argue that this condition is explanatory of individuals' guidance.

> *Actual condition*
> If an individual guides her attention-shifts toward some goal, then her executive system regulates processing across pertinent sub-systems for attaining that goal.

The executive system is an empirically discovered psychological sub-system, roughly at the top of the hierarchy of sub-systems, that functions to regulate psychological processes. It helps initiate, sustain, and terminate them. It organizes processing and storage resources for carrying out psychological processes. It coordinates their simultaneous or sequential execution. The executive system regulates a psychological process by flexibly allocating processing and storage resources for its completion.[45] The system thus accesses and regulates a wide range of sub-systems.

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[44] Even working memory can *draw* attention. (Soto, Humphreys, & Heinke 2006; Soto, Hodsoll, Rotshtein & Humphreys 2008; Soto, Humphreys, Heinke & Blanco 2005)

[45] See Miyake et al. 2000; Miller & Cohen 2001; Baddeley 2007; Koechlin 2007, 2014; Diamond 2013; Gazzaniga et ak. 2014; Goldstein et al. 2014; Botvinick & Cohen 2014; Fuster 2015. The conception of the executive system that I sketch here is grounded in psychology. I do not commit to the details of specific psychological account of the executive system. For more on the executive system, see [redacted] I think of the different executive functions as components of a mechanism constituting the individual's capacity to guide. The executive system is a sub-system of the individual minimally insofar as this system itself is a component in mechanistic explanation of the whole individual's capacity to guide. (Craver 2007; Weiskopf 2018) See [redacted] for more on explanatory levels. Thanks to a reviewer for pressing these issues.

Figure 3

The executive system allocates resources and manages storage by exercising *executive functions*. Executive functions are specific competencies for regulating psychological processes. The executive functions are signature competencies that characterize the functioning of the executive system.

Switching of mental set, resource-allocation, maintenance of relevant memories, and inhibition of prepotent responses and interfering stimuli are the most frequently recognized executive functions. These functions are fairly precisely characterized. A set of well-studied, relatively simple tasks requires exercising these functions and allows their investigation.[46]

Switching of mental set consists in abandoning one psychological process and initiating another. A mental set is the suite of psychological states and events required for completing a psychological process.

Maintenance of relevant representations in memory consists in the activation and holding active of relevant long-term memories. Maintenance includes the encoding of incoming task-relevant information into working memory. *Resource-allocation* involves the deployment of executive processing resources for the execution of some task or part of a task. These resources function to enhance the processing to which they are allocated. *Inhibition* consists in the exercise of a competency to suppress dominant, automatic, or prepotent responses and distracting or interfering stimuli and information.

The executive system is one of many psychological sub-systems that enter psychological explanations. We must distinguish it from the individual herself. Individuals act. Individuals guide their acts. Psychological *systems* do not act. But individuals' exercises of agency (partly) consist in the activity of these individuals' sub-systems. Individuals' guidance in shifting attention correlates with the executive system's regulation of other sub-systems and is absent from non-guided shifts.

The executive system forms part of the endogenous system for shifting attention. As such it shares the properties mentioned in motivating the preliminary condition. The executive system regulates processes underlying attention-shifts, even in cases where

[46] Miyake & Shah 1999; Jurado & Roselli 2007; Anderson, Jacobs & Anderson 2008; Baddeley 2007

exogenous factors, or other endogenous factors, draw attention and interfere with search. In making room for these factors, the present proposal improves on the preliminary condition.[47]

Remember the macaque's visually searching for a raspberry. The monkey guides his attention from a leaf, to a twig, to a bug. He continues to shift his visual attention across the brushes until he has found the berry. The executive system's regulation corresponds to the guidance that the individual herself exercises.

When the monkey sets a raspberry as the goal of his search, the executive system activates an iconic memory of the raspberry. The activated memory partly constitutes the monkey's setting the berry *as* the goal of the psychological process – the visual search – that ensues. The executive system activates the visual attentional system *for search* by providing the iconic memory of the raspberry as the target-template input for this system's computations. The target-template input by the executive system governs, determines, and shapes the activity of the visual attentional system.[48]

When the monkey begins to search for the raspberry, the executive system initiates computations of a priority assignment for locations on the priority map. The computational mechanisms underlying the priority map generate a ranking of locations as more or less likely to contain the target of the search. They determine priority on the basis of visual similarity between items at locations and the target-representation in working memory.[49]

When the monkey shifts visual attention to the first location – a leaf – the priority map represents *that* location as the destination for visual attention. This representation helps cause attention to shift. Suppose that the monkey briefly fixates attention on the leaf and sees that there are no berries there. The attentional system deploys visual attentional resources to determine that the item at the fixated location does not match the template. The executive system registers absence of the target from that location in a visuo-spatial working memory. When the monkey shifts attention to the next location – a

[47] Wayne Wu (2016, 108) and Ellen Fridland (2014, sect. 4.2) have proposed that such attention-shifts must be semantically integrated with individuals' intentions, or top-down biased by their contents. My proposal might be used to specify how the relevant integration or biasing must work. Thanks to a reviewer for prompting clarification.
[48] Zelinsky 2008
[49] Geisler & Cormack 2011; Nayemnik & Geisler 2009; Zelinsky 2008

twig – the priority map represents this new location as the most likely location for the target. This computation takes as inputs both target-template and memory of the already visited location. From this information, the mechanism underlying the priority map computes a new ranking for likely target-locations. The resulting new map-assignment helps cause the next attention-shift. This process repeats until search terminates. When the monkey finds the berry, the attentional system computes a sufficient match between the item at a location and the iconic representation of the berry. The executive system may now switch mental set from the goal of finding the berry to that of reaching for it.

The priority map indicates where to shift attention, for each shift during visual search. The executive system regulates priority-computations. The monkey's guidance of his shifts partly consists in this regulation.

Even in this simple instance of visual search, the executive system may exercise all four signature executive functions. First, in activating the target template and holding it in working memory as a goal, the executive system *switches* from whatever task the monkey was carrying out before to that of finding the raspberry. Second, the executive system *maintains* representations activated from long-term memory and stored in working memory, and their influence on the computations of the priority map. Third, the executive system boosts the influence of a goal-representation relative to other factors by *allocating resources* to it. Fourth, the executive system *inhibits* the influence of physically salient distractors or non-guiding endogenous factors on the priority map. The system suppresses alternative processes, such as planning a route into the crowns of surrounding trees.[50]

Executive regulation correlates with individuals' guidance of attention-shifts at the level of psychological systems. It is absent from non-guided attention-shifts. Thus, attention might be captured during visual search – maybe a snake approaches while the monkey is scanning the brush. The exogenous attentional system assigns priority for a shift to the location of the snake. The shift is not driven by the individual's goal of finding the berry. The exogenous system overrides the executive system's regulation of computations determining priority on the map that causes attention-shifts. When the

[50] Of course, not *all* executive functions need be exercised, for the executive system to regulate some psychological process. The executive system might regulate, e.g. by allocating central resources to a process, even if no memory and inhibition are required for its execution.

individual's attention is captured, the executive system does not, or no longer, regulate priority computations. Similarly for attention-shifts during default activity. When the monkey stares at his surroundings while being groomed, saliency-based computations determine rankings of locations on the priority map. The executive system does not influence these computations of priority on the map.

Earlier I explained that physically salient stimuli and a range of non-guiding endogenous factors could draw attention even during active shifts. Suppose, again, that the monkey searches for his raspberry. His first fixation lands on the leaf. His goal of finding a raspberry drives this shift of attention to the leaf. Now suppose, further, that the leaf is physically salient. The exogenous system's modulation of priority assignments on the map interferes with executive regulation of priority computations, without interrupting the search. The leaf attracts attention because it is physically salient. Or suppose that the leaf attracts attention because the monkey has implicitly memorized its location as statistically likely to contain a berry. This memory increases priority for the leaf's location. The executive system continues to regulate priority-computation, but does not do so perfectly.

There is ample evidence for all four signature executive functions in visual search. First, consider *resource-allocation*. Olivers and Eimer's[51] subjects had to memorize a color, perform a visual search, and a memory test. The memorized color influenced attention-shifts during a subsequent search. When their subjects could not predict whether they would first complete the search or the memory test, individuals set *both* goals to guide subsequent psychological processing. Olivers and Eimer found that the effect of the memorized color on the subsequent search doubled, relative to the condition where individuals could predict which task they would have to complete next. Olivers and Eimer explained this result as due to the allocation of executive resources to *both* representations governing the psychological processes.

Figure 4

[51] Olivers & Eimer 2011; Olivers, Meijer & Theeuwes 2006; Olivers, Peters, Houtkamp & Roelfsma 2011

Maintenance of relevant representations in memory is required for the execution of visual search. For example, Oh and Kim[52] showed that when individuals had to memorize locations of four squares on a screen, a subsequent visual search slowed down. Individuals were less effective at finding the search target. Oh and Kim explained their result by pointing out that these individuals' visuo-spatial working memory was filled to capacity. If the memory storage for locations is filled, the executive cannot effectively regulate assignments of priority on the priority map.

Switching of mental set is required to abandon a task and initiate a visual search. Walther and Fei-Fei[53] showed that visual search exhibits typical effects of switching. They asked subjects to switch back and forth between the task of searching for a target in a display, and that of reporting the color of the display's frame. The executive system takes between 200 ms and 800 ms to switch tasks. Individuals' performance on the second task was only impaired when they had less than 200 ms to switch sets. These experiments support the claim that switching to the set for visual search, and establishing this set, requires exercising the relevant executive function.

Inhibition of irrelevant distractors is required to search a cluttered display. Lavie et al.[54] found that individuals shift attention to distractors more often, when they had to concurrently generate random numbers or perform calculations. The number of individuals' attention-shifts to a distractor, and the amount of time they needed to find the target, increased in proportion with the amount of unrelated processing individuals had to carry out. Lavie et al. thus support that the executive system is needed, in visual search, to inhibit the detrimental effect of distractors.[55]

This concludes my argument for the *actual condition*.

3 Executive regulation as explanatory of individuals' guidance

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[52] Oh & Kim 2004; Woodman & Luck 2004
[53] Walther & Fei-Fei 2007; cf. also Lavie, Hirst, De Fockert & Viding 2004
[54] Lavie & De Fockert 2005; Lavie, 2000; Fukuda & Vogel 2009; Lavie & Dalton 2014
[55] Individuals also guide attention shifts outside of visual search. We have already seen that individuals can intentionally guide their attention to some specific object, location, or region. Shifts subserving more complex, goal-driven intentional actions form another large class of active attention shifts. One sub-class of these shifts consists in shifts subserving motor behavior. (Hayhoe & Ballard 2005; Land 2006; Sprague, Ballard & Robinson 2007; Land 2009) Another sub-class of shifts is directed toward the goal of acquiring information. (Ballard & Hayhoe 2009; Babcock, Lipps & Pelz. 2002; Canosa, Pelz, Mennie & Peak2003)

The executive system's regulation of pertinent sub-systems, I argued, is a condition on individuals' guidance of these shifts. In this section I argue that:

> *Explanatory condition*
> An individual's guidance of her attention-shifts toward some goal can be explained by her executive system's regulating processing across pertinent sub-systems for attaining that goal.

My view is that the individual's capacity to guide her attention-shifts is (partly) constituted by her executive system. This fact allows us to explain individuals' guidance by appeal to the operation of this sub-system. I will here not argue for the claim about constitution, but focus on the claim about explanation instead.[56]

To explain how individuals guide, we must explain how they direct their activities toward some goal, and we must explain why this guidance is attributable to the whole individual.[57] I will now argue that appeals to executive regulation help with both explanatory tasks. I will reflect on our conceptions of the target phenomena – *goal-directed guidance* and *individual-level states/events* – to characterize the explanandum. The phenomena are characterized by certain marks.[58] Attention-shifts guided by the individual typically exhibit these marks. I will show how appeals to executive regulation explain the fact that guided attention-shifts exhibit these marks. In doing so I will have argued that the executive system's regulation of processes across sub-systems helps explain *both* the goal-directedness of visual attention-shifts, *and* the attributability of this goal-direction to the whole individual.

How do appeals to executive regulation help us explain the goal-directedness of active attention-shifts? What marks goal-directed guidance? Consider the example of a mountain guide. First, the good guide *sets the goal* for the expedition's ascent. She picks a peak as her expedition's destination and orients her expedition toward the peak. Second, the good mountain guide *coordinates* activity in the expedition. She brings the

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[56] The fact that executive regulation both correlates with, and explains, individuals' guidance does provide an argument for the claim that the executive system constitutes a capacity to guide. [redacted]

[57] Frankfurt 1978

[58] Marks do not constitute a definition. They are paradigmatic characteristics of items in the extension of a concept.

rope, pickax, and crampons. She tells members when to put on the crampons, or when to scale a rock with rope and pickax. Third, a good mountain guide *compensates for interference*, as needed, to stably steer toward the goal of the expedition. She will give members of the expedition the occasional push to get them across a crevasse.

We find each of these marks of goal-directed guidance in shifts of visual attention during visual search. When the macaque searches for berries, he sets some specific kind of berry as the goal of his visual search. During his search, activities across sub-systems coordinate – whether those be activations of memory-representations, processing of visual stimuli, or of goal-input, for priority computations. Finally, visual search exhibits compensation for interference, as when the influence of some distractor stimulus is suppressed so as to yield saccades typical of drawn attention.

Appeals to the executive system help us understand the goal-directedness of certain behaviors by connecting it with a kind – executive regulation – that appears in psychological explanations. Reflection on this kind reveals how executive regulation generates the marks of goal-directed guidance laid out in the foregoing paragraph. Such reflection shows how appeal to this empirical condition helps explain goal-directed guidance, for the case of visual search, in actual psychologies.

First, appeals to the executive system help explain what the *setting of a goal* for a process consists in. Individuals' goal-setting for visual search partly consists in the activation of some goal-representation through switching set. This activation helps initiate computations of priority for locations on the priority map. The activation also typically effects encoding of the goal-representation into working memory, where the representation is maintained throughout visual search. Being maintained in working memory, the representation sustains its causal influence on priority computations, until search is completed. The representation informs resource-allocation to, and inhibition of, activity in sub-systems, depending on their relevance to finding the berry. The goal thus causally shapes search throughout its duration.

Second, appeals to the executive system explain how pertinent activities in other psychological sub-systems are *coordinated* for attaining the goal. Switching involves the activation of a search-set. This activation initiates processing in pertinent sub-systems, such as processing of goal-representations, memory-representations, visual stimuli, and priority-computations. Executive regulation thus coordinates by activating the right set for finding the berry. Executive regulation *also* coordinates by allocating resources in light of this goal, or by inhibiting processing of distractors. For instance, executive regulation may boost visual discrimination at a likely target-location, or suppress the influence of a misleading scene-memory on priority-computations.

Third, appeals to the executive system explain how individuals *compensate for interference* when searching for a visual target. In visual search the system's inhibitory function can suppress processing of interfering, salient stimuli from locations that likely do not contain the search target. Alternatively, the system may boost the influence on priority of information to the effect that the salient location does not contain the target, thereby counteracting the influence of information from this location on priority-computations.

We can thus explain why goal-directed guidance exhibits these marks, by appreciating how executive regulation generates them.

How do appeals to executive regulation help us explain the attributability of guidance to the whole individual?

I approach this question by reflecting on marks of individual-level states and events. What marks states and events of a whole individual, as opposed to merely her sub-systems? Such states are typically (rationally) *integrated with the individual's central states/events*, and they exhibit *characteristic whole-individual coordination* of the activities of individuals' parts.[59] Whole-individual states, like a belief that some wall is blue, are integrated in that they can be rationally affected by, for instance, incoming perceptual information to the effect that the wall is yellow, in virtue of the perception's content, causing the belief to change. Whole-individual events like walking exhibit characteristic coordination of the individual's leg-movements with those of her arms, and

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[59] The literature acknowledges *three* marks of individual-level states and events. The third mark is their being phenomenally conscious. States of the executive system are often conscious. This fact supports the idea that the executive system underlies individual-level states and events. The fact justifies predictions that guidance-events will often be conscious. But since I reject a functional explanation of phenomenal consciousness, I do not think that appeals to executive regulation explain states and events' being conscious in any interesting sense. For this reason I relegate the third mark of individual-level states and events to this footnote. See Burge 2010, 369ff.; on consciousness cf. Dennett 1968; on integration cf. Stich 1978; Fodor 1983; Burge 2009; on coordination cf. Frankfurt 1978; Burge 2009; Hyman 2012.

with her posture.

We find these marks in guidance-events during visual search. When the macaque guides his visual attention in search for a berry, this guidance-event is typically integrated with his central states. Depending on the kind of animal, guidance may even be *rationally* integrated. Thus, the individual's guidance is toward the individual's goals. His intentions, beliefs, expectations, perceptions, and so forth, help determine where and how she searches for the berries. Rational deliberation about search-strategy will affect the pattern of attention-shifts, much as will visual information about the monkey's surroundings. A change in the macaque's goals will affect his guidance of his search, such as when he decides to abandon search and walk away. The search similarly exhibits characteristic whole-individual coordination. Processing of information about the target – its visual properties, say – coordinates with processing of information about this target from memory, such as its likely locations, changes in appearance due to lighting, or what locations the monkey has already searched. Such processing coordinates movements of the body – with shifts of the eyes, movements of the torso, and overall posture of the rest of the body.

Again, appeals to the executive system help us understand attributability of guidance to the whole individual by connecting it with a kind – executive regulation – that appears in psychological explanations. Executive regulation generates the marks of individual-level states/events just identified. Appeal to this empirical condition on individuals' guidance helps explain its attributability to whole individuals, for the case of visual search, in actual psychologies.

First, appeals to executive regulation explain why guidance-events in visual search are typically *integrated with individuals' central states/events*. This explanation appeals to the fact that the executive system functions to access and regulate a wide range of psychological systems.[60] It thus characteristically connects with a wide range of other sub-systems. Its activity is characteristically non-modular, intermodal, accessed, and penetrated. These sub-systems include systems to be regulated as well as systems that inform executive regulation. Depending on the kind of individual under consideration, such integration may be rational integration, or integration of some more primitive kind.

[60] See section 2.3

Thus, what kind of search-goal the executive system sets depends on the individual's goals and intentions. What representational states and competencies the executive system activates depends on the individual's goals, intentions, memories, beliefs, and perceptions. This dependency may take the form of rational deliberation. *How* she guides her visual attention shifts depends on her executive system's continuously regulating the influence of each of these different kinds of central states on priority-computations. Thus, executive regulation may increase the influence on priority-computations of a belief to the effect that the target is in some specific location; or suppress the influence of a salient stimulus because the individual believes that the stimulus is a distractor.

Second, appeals to executive regulation explain how guidance-events exhibit *characteristic whole-individual coordination* of individuals' parts. We have already seen how the executive system generates goal-directed guidance of visual search. Such direction involves a kind of coordination. When the individual guides her attention-shifts in search for a berry, her executive system activates the relevant set by switching into it. Switching achieves coordination by activating pertinent sub-systems and de-activating others. The executive system regulates other sub-systems through allocation of resources to processes in support of goal-attainment, and inhibition of processing of interfering stimuli. But what coordination is of the right kind to mark *individual*-level states and events? I do not have a general characterization of this kind of coordination. Nevertheless, coordination that is both in light of the *individual's* goal, and that, in about any case, is of activities across (more or less) *all* of the individual's sub-systems (and other parts), plausibly is an instance of such coordination. Now importantly, the executive system does regulate a wide range of different sub-systems, across the individual's parts. These sub-systems include cognitive, perceptual, memory, and motor systems. The executive system thus coordinates activity not merely of a narrowly circumscribed range of sub-systems, but arguably of sub-systems across the entire individual. Furthermore, such coordination does function to operate in light of *individuals'* goals. Executive regulation during visual search takes individuals' goals as inputs. Indeed, the executive system is the only known psychological structure that both coordinates across such a wide range of individuals' parts, and in light of her goals. Appeals to executive regulation thus plausibly explain how guidance-events exhibit a kind of coordination characteristic of whole individuals.

In each of these ways, appeals to executive regulation explain marks of individual-level states/events. We can explain why guidance during visual search exhibits these marks by appreciating how executive regulation generates them.

This concludes my argument in support of the claim that executive regulation constitutes an explanatory condition on individuals' guidance of their visual attention-shifts.

4 Conclusion: Skilled guidance

I have argued that executive regulation both correlates with, and explains, exercises of individuals' guidance of their visual attention-shifts. I have argued for these claims, first, by providing a close scrutiny of the different control-structures involved in attention-shifts. Among these control-structures, I argued, executive regulation of processing in other sub-systems most closely correlates with exercises of individuals' guidance. Such regulation imposes a condition on individuals' guidance of their attention-shifts. Next, I argued that executive regulation generates, and can thus explain, marks of individuals' guidance. No other condition appears closely correlates with individuals' guidance, and generates and explains its marks. Together, these facts warrant a stronger claim:

> *Individuals' guidance*
> An individual's guidance of her attention-shifts toward some goal partly consists in her executive system's regulating processing across pertinent sub-systems, for attaining that goal.

At the level of psychological sub-systems, an individual's capacity to guide consists in her executive system. Guidance partly consists in the operation of this system. When the individual guides her attention-shifts toward a goal, then her executive system regulates processing across other sub-subsystems, so as to attain that goal.

We are now also in a better position to appreciate why individuals' guidance, and hence executive regulation, is central to understanding skilled action. Earlier I pointed out that the debate concerning skilled action revolves around control-structures involved in such action. But, in central cases, such control-structures only contribute to exercises of skilled action, if they are components of, the individual's guidance of that action. Only then are they an aspect of how she controls her action in exercising skill. The control-structure's mere presence in the individual's psychology does not yet make it part of her agency. Even the control-structure's causal influence on the action does not do so. Such an influence might interfere with her guidance, or be otherwise extraneous to her agency. For the case of visual attention, I have argued, the individual's guidance of her activities consists in the operation of the control-structure *only if* the executive system regulates that control-structure for attaining the individual's goal. So if we are interested in the role of a control-structure in skilled action, we must ask about its connection to executive regulation.

Delving into the empirical detail about shifts of visual attention illustrates why interest in control-structures is well placed. Even a relatively simple visual skill, such as visual search, involves a wide range of such structures: computations of visual saliency; long-term, implicit, and statistical memories concerning the relevance of certain stimuli, types of visual scene, configurations in scenes, and reward-association with stimuli; visual representations of search-targets, as well as processes of template-matching; propositional intentions, expectations, search strategies, reasoning about where to attend next; and, of course, the very mechanism that computes priority-assignments in light of influences from these different factors. Each of these different structures can influence how priority is computed on the map, and hence, help control how attention shifts. Each of them can, itself, exhibit a kind of excellence. Each can thus, in principle, contribute to the excellence of skilled action. The monkey may have especially reliable or high-capacity long-term statistical memory for where a target is typically located in some kind of scene. The monkey may be especially good at finding a strategy for searching efficiently. We can recognize the underlying control-structure as exceeding some relevant standard of goodness. Its excellence can, in turn, help make excellent the visual skill's exercises.

But interest in conditions under which individuals guide activities is, in a sense, prior to our interest in different control-structures. For, the different structures and their excellence contribute to the individual's control over her activities, and her excellence at acting, only to the extent that they help constitute her guidance. They help constitute the individual's guidance, in turn, only insofar as they are appropriately regulated by the executive system. Here are two illustrations.

Suppose that the monkey has excellent statistical scene-memory of the kind just described. The memory's excellence bears on the individual's visual skill only to the extent that executive regulation activates the memory for visual search. For, only if executive regulation activates the memory *for search* is it a component of the individual's guidance. So activated, the memory can enhance the individual's search in ways described earlier. It can determine priority-assignments on the map for shifting attention, increasing priority of locations that likely contain targets. Absent activation by the executive system, the scene-memory may still exercise control over priority-computations, and hence the individual's search. A salient visual stimulus, or some other psychological factor, may activate the memory. But, we have seen, in these circumstances, the memory may just as well interfere with the individual's guidance of her search.[61] The memory is then not a component of the individual's capacity to guide her search. It is rather an impediment to her guidance. The role of visual scene-memories, low-level mechanism for computing assignments on the priority-map, and low-level visual-like representational states parallels the role of low-level motor computations and motor representations in bodily action. Under what circumstances does individuals' control of skilled action partly consist in such low-level processes, rather than their constituting "two centers of agency present in the skilled" action?[62] For the case of this visual skill, the answer is: only if those processes are regulated by the executive system.

Or suppose that the monkey exercises a capacity for problem-solving. Suppose that the monkey has reasoned that the berries are most likely located in certain parts of the visual scene and attention should thus initially shift there. This strategy's excellence bears on the individual's skill at searching only if executive regulation activates it for search. So activated, it can influence priority computations and thus where attention shifts. Executive resource-allocation and inhibition may increase the strategy's influence on attention-shifts by boosting its effect on priority-assignments, or by suppressing the

[61] Cf. section 2.2
[62] Shepherd 2019, 288

influence of other structures. Absent such activation, the strategy may not have any influence on priority computations. It may be causally inert. Alternatively, this kind of strategy may linger in the individual's psychology from some earlier task-context. Suppose that an earlier search for worms warranted prioritizing the ground beneath the berry-bearing bushes. This strategy may be activated by some psychological factor other than executive regulation. In this case, the strategy interferes with search.[63] Absent executive regulation, the strategy's influence on action does not manifest skill, but its lack. The strategy is then not a component of the individuals' guidance of search. It does not contribute to the search's excellence. When are problem-solving and practical reasoning elements of skilled action? To what extent do they help control skilled action? For the case of visual skill, the answer is: to the extent that those processes inform executive regulation of other sub-systems throughout the execution of the action.

To repeat: the mere presence of some control-structure, and its influence on some skilled action, is not enough for it to be an element in the exercise of skilled action. Only if appropriately regulated by the executive system are memories, strategies, or beliefs, components of the individual's guidance. Only then are they aspects of her skill in performing visual search. And only then does the excellence of some such control-structure contribute to her excellence at performing this kind of action. Questions concerning the role of other control-structures discussed in the literature must be similarly discussed in the context of guidance.

Questions concerning the integration of different capacities in skilled action, too, should be tied back to questions about guidance: integration-challenges, globally, concern how different capacities are integrated, or interface, so as to systematically promote individuals' guidance of their activities toward some goal, and such that this guidance exhibits excellence.[64] So, questions concerning such interaction will have to primarily be addressed in context of executive regulation. Capacities interface, in constituting the individual's guidance, primarily insofar as the executive system regulates their interaction. How they interface will be partly a question concerning how executive regulation operates in drawing on different capacities to attain the individual's goal. Only

[63] Cf. section 2.2
[64] Butterfill & Sinigaglia 2014; Mylopoulos & Pacherie 2017; Fridland 2017, 2019

through addressing questions about guidance can we can tie back investigations of control-structures to our interest in skilled action.

Psychologically speaking, then, we have two primary constituents, and hence determinants of excellence, in skilled action: first, the excellence of component-capacities involved in some instance of guidance; and second, excellence of executive regulation. Questions concerning the role of specific control-structures in skilled action concern their recruitment by executive regulation. Questions concerning the interaction of different capacities concern their coordination by the executive system.

Efficiently shifting visual attention or carrying out search is an important visual skill in its own right. It is of crucial relevance in epistemology, in practical and moral reasoning, as in the control of bodily action. I have tried to establish the importance of executive regulation in addressing these questions *only* for the case of visual attention-shifts. But I do believe that a similar argument can be given for all other kinds of human action, too. So I do believe that these points will be of relevance in understanding skill and skilled action more generally.

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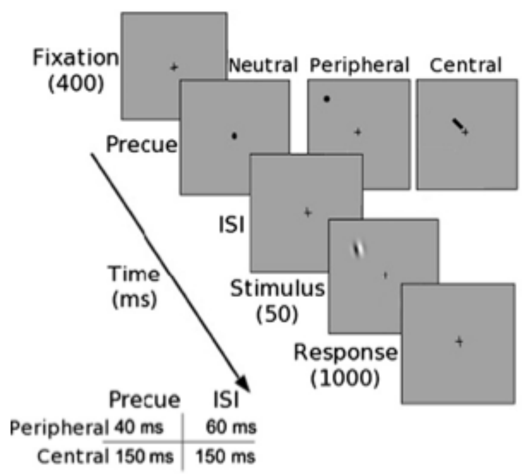
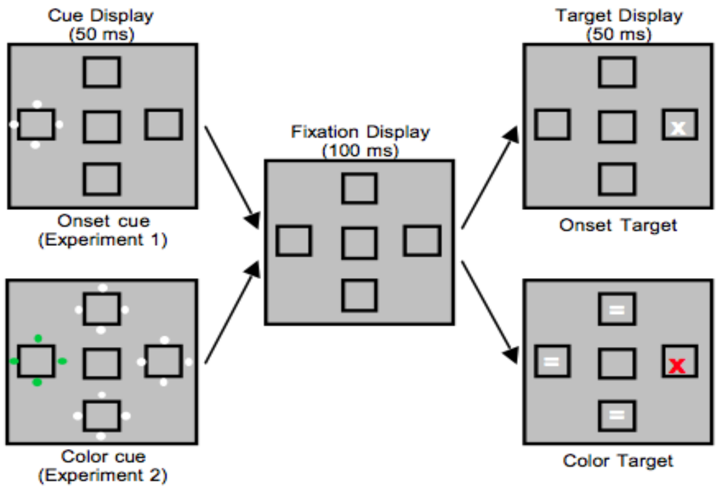
Figures

Figure 1



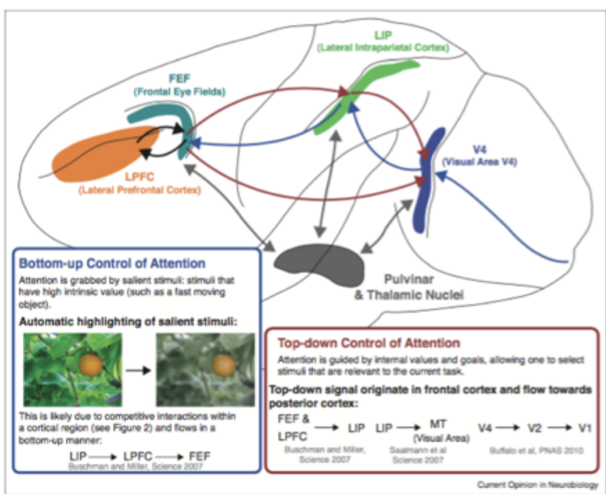
[Displays used in Posner's 1980 study. From Carrasco 2011.]

Figure 2



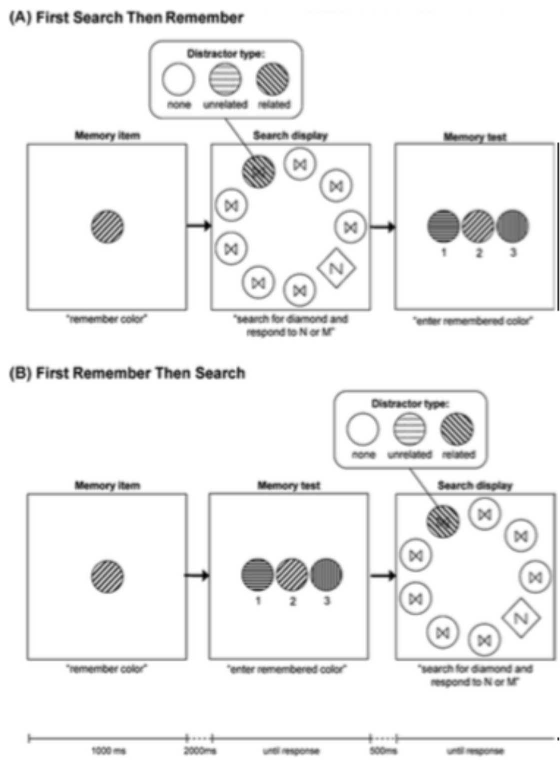
[Displays in the Folk et al. paradigm. From Theeuwes 2010]

Figure 3



[The hierarchy of *psychological* sub-systems as mirrored in the brain. The executive system, implemented in frontal and prefrontal cortex, regulates processing in other sub-systems through long-range connections with other parts of the brain. Miller & Buschman 2013.]

Figure 4



[Displays from Olivers & Eimer 2011]