# How To Saw The Concept of Attention In Half Without Sacrificing the Subject:
## Review of *The Psychology of Attention* by Harold Pashler

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REVIEW OF: Harold Pashler (1998). *The Psychology of Attention.* MIT Press: Cambridge, Mass. ISBN 0-262-16165-6, xiv + 494 pp, 50 illustrations, $49.50 (US), hard (cloth) cover.

# 1. Introduction

Harold Pashler has published many seminal, insightful, and influential papers in the domain of attention and cognition. The remarkable implications of this output, however, have not been fully appreciated. Fortunately, this monograph integrates these observations to create a unified and compelling view of attention.

During the 1980s, Pashler devised and promulgated a technique that could potentially locate the bottleneck in the information processing chain, the mechanism responsible for limitations in cognition. This technique exploited the psychological refractory period (PRP), the observation that performance degrades when two discrete tasks are undertaken in rapid succession. In several studies, Pashler manipulated the asynchrony between the onset of these tasks. The pattern of interactions between this asynchrony and other variables, such as stimulus quality, was claimed to reflect the locus of any bottleneck that

may underlie cognition. This paradigm was arguably the most vital addition to the arsenal of cognitive psychology, and the flurry of activity that ensued generated a consistent pattern of results. In particular, the bottleneck was confined to selecting a response.

Pashler's work, however, extends well beyond this paradigm and ventures into the realms of visual search, change blindness, priming, short-term memory, and many other areas of attention. For instance, a series of studies in the 1980s revealed that perceptual attention is functionally distinct from the central bottleneck. Other experiments have demonstrated that stages or processes protracted by degrading stimuli can be undertaken on many items in parallel.

## 2. Misconceptions in the Literature

The book is roughly divided into two parts. The first part reviews the vast and piecemeal literature on attention, with an emphasis on filtering, search, and cueing tasks. The second part derives a theory to reconcile these observations, discusses some paradigms that directly corroborate and refine these arguments, and then extends this framework to incorporate various aspects of memory, automaticity, effort, and control.

The literature review canvasses a broad spectrum of experiments and findings. During most of these discussions, Pashler chooses to hold "theory at bay insofar as possible" (p. 163). Notwithstanding this, the review is surprisingly engrossing, as Pashler penetrates the dense thicket of findings and contradictions. The decision to sever data from theory allows Pashler to scrutinise, and often invalidate, many of the findings that have hitherto been regarded as indubitable. For instance, a spate of studies have demonstrated that elevating the number of items in a display will, under certain conditions, augment the time that is required to locate a specific target. This sloping relationship between search time and display size is often thought to reflect a capacity limit in processing. In a lucid rebuttal of this view, Pashler explains that statistical reasons alone can accommodate this relationship. In a similar vein, the majority of cueing effects can also be attributed to statistical noise. As a consequence of these arguments, a large chunk of this literature can be dismissed or at least queried. To add fuel to the flame, Pashler then reveals that most of the studies that were designed to circumvent these problems are also flawed.

Furthermore, many other findings are ruthlessly impugned. For example, evidence that unattended stimuli are processed semantically abounds in the literature, as revealed by indirect methods such as physiological measures. Pashler argues, however, that virtually all of these findings can be accommodated by lapses in concentration. When these lapses are precluded, the findings are clearly reversed. Another crucial insight concerns the notion of automaticity. According to Pashler, "the phenomenology of automatization may be so compelling that experimental data scarcely seem relevant" (p. 381). Pashler reveals that literature in this domain is entirely bereft of data that substantiate the principal elements of automaticity. In particular, the notion that some processes are involuntary and do not disrupt ongoing activities cannot be unequivocally sustained. The ability to

suppress putatively automatic processes, the notion that supposedly continuous activities can be undertaken in a punctate manner, the finding that PRP is not eliminated by practice, and other considerations all conspire to undermine the notion of automaticity. In the end, automaticity is portrayed as a hollow and almost untenable concept.

Many other misconceptions are exploded. For instance, Pashler clarifies the tenets that underlie late selection theories. Most researchers in this field recognise that early selection theories assume that only attended stimuli are categorized and identified. In contrast, late selection theories propose that unattended stimuli can also be identified. Nonetheless, contrary to popular opinion, late selection theories do not presuppose that all proximal stimuli are identified; factors such as eccentricity and masking could preclude these processes. A host of other examples also abound, especially in relation to cueing tasks, negative priming, and Miller's (1987) flankers task.

# 3. Principal Findings

The literature review does not merely invalidate previous findings, but also expands the empirical base. Many fascinating results are underscored, including a wealth of unpublished data generated by Pashler and his associates. For instance, in one study, participants were asked to construct a mental image of an object, such as a swimming pool. A series of slides were then presented in rapid succession. Occasionally, a slide that represented the mental image was presented, closely followed by a pre-defined target. In these trials, the targets were often overlooked. This finding, together with the observation that two targets cannot be identified in close succession, reveals that items that mirror a concurrent mental image are invariably detected. This elegant study, as well as a variety of other experiments, seemed to resolve issues that had previously eluded investigation.

Indeed, this review is rife with studies conducted by Pashler and his colleagues. The ramifications of his past studies have sometimes been obscured in the publications, perhaps because of word constraints and cognate factors. In this monograph, however, the significance of each study is undeniable. Many readers will continually castigate themselves for not having thought of these experiments before.

Towards the end of this review, Pashler enumerates 14 principal findings that have emerged from the literature. One finding is that distractors are less effectual when the number of items is augmented. Another finding is that detecting one target reduces the likelihood of detecting another target soon after, and so forth.

# 4. A Theory of Attention

Midway through his book, Pashler sketches out a framework to accommodate this sprawling literature. The centrepiece of this framework is that attention entails two distinct components. The first component relates to perceptual attention. In this scheme, perceptual attention is conceptualised as both a gate, which selects only a subset of the proximal environment, and a resource, which can be allotted to various stimuli in a graded fashion.

In relation to perceptual attention, Pashler resolves the distinction between early and late selection with his trademark insight. Pashler observes that "many (investigators) simply seem weary of the battle but uncertain of its resolution" (p. 399). This uncertainty soon evaporates however. According to Pashler, two questions have been erroneously conflated. First, is unattended information processed semantically? Second, can more than one item be identified simultaneously? Most researchers have assumed that both questions must yield the same response, either in the affirmative or the negative. In stark contrast, Pashler provides a breath of fresh air when he reveals that unattended information is generally not processed semantically, but several items can be attended and identified at once, a notion that he dubs controlled parallel processing. The support for this claim is virtually incontrovertible.

The second component of attention is a bottleneck that corresponds to selecting a response. This bottleneck, which emerged from the PRP studies, can select only one response at a time. In other words, the bottleneck, by definition, cannot be distributed across tasks or stimuli. In this sense, Pashler has resurrected and refined the beleaguered single-channel hypothesis.

This framework is intuitive but intriguing, and it facilitates the explication of many slippery issues. For instance, is visual and auditory processing subserved by the same mechanism of attention? What is the aftermath of stimuli that do not receive attention? Is every element of an object selected as a unit? The answer to each of these questions is contingent upon which component of attention is under consideration. For example, perceptual attention most likely selects all elements of an object as a unitary whole. In contrast, the central bottleneck selects only those elements that are germane to the task at hand.

After outlining this framework, Pashler then applies the coup de grace as he relates attention to memory. First, the modal view of memory is championed. Next, the relationship between each element of memory and the two components of attention are delineated. For instance, Pashler carefully reveals that retrieval from long-term memory utilises the central bottleneck.

Perhaps the most enlightening component in this endeavour is the link between short-term memory and the central bottleneck. Many authors have tacitly, or even explicitly, assumed that attention is virtually tantamount to the executive component of working memory. Despite this prevailing assumption, Pashler reveals that short-term memory is entirely separate from the central bottleneck; in other words, raising the memory load

does not occupy the central bottleneck. Instead, short-term memory is intimately linked to perceptual attention.


# 5. Multiple Resources, Cross-Talk, and Cortical Distance

In the preface to this monograph, Pashler notes that "efforts to relate different attentional phenomenon to each other have dwindled somewhat" (p. ix). Nonetheless, apart from his own theory, a number of alternatives have been proffered. One framework that has been the subject of appreciable support and derision is the multiple resource approach (e.g., Wickens, 1984). This theory assumes that cognition relies on the availability of resources, such as memory stores, energy sources, and processing mechanisms. These resources can be subdivided into functional sets called pools. Similar tasks tend to utilise the same pools and will thus interfere with each other when undertaken concurrently.

Pashler criticises this broad brush approach and regards this theory as inimical to a thorough understanding of attention. Nonetheless, Pashler's model can be conceptualised as a highly developed and refined incarnation of the multiple resource theory. Both theories assume that limitations in cognition arise from several distinct sources. But the view espoused by Pashler is more elegant and complete. For Pashler, some elements of attention, such as the central bottleneck, cannot be strategically distributed across stimuli. Furthermore, in contrast to the multiple resource approach, the relationship between each component of information processing is delineated convincingly. For instance, limitations in preparation are clearly imputed to short-term memory; this issue is somewhat nebulous in the framework of multiple resources.

Pashler's theory also absorbs another potential rival, the notion of outcome conflicts or cross-talk (e.g., Navon, 1985). According to this notion, processing codes associated with one task may disrupt processing codes associated with another, concurrently performed activity. These disruptions are especially rife when the tasks are similar and thus entail common processes. Pashler concedes that cross-talk may constrain dual-task performance, but confines these conflicts to short-term memory. This restriction yields the vital prediction that cross-talk will not emerge when the tasks do not impose on short-term memory, a prediction that has received considerable support from PRP studies.

The final alternative is Kinsbourne and Hick's (1978) cortical distance notion. According to this theory, dual-task performance will be efficient when the activities are subserved by functionally separate cortical areas, such as different hemispheres. After a close scrutiny of relevant studies, Pashler keenly observes that activities associated with different hemispheres can be conjoined effectively, provided that both tasks do not rely heavily on response selection. This principle suggests that cortical distance may play a cameo role in dual-task interference, but is typically overwhelmed by the central

bottleneck. Despite its post hoc flavour, this claim seems to accommodate these data more effectively than any other extant alternative.

# 6. Assets and Shortfalls

This monograph comprises many other attractive and absorbing elements. First, Pashler tackles a number of thorny philosophical issues with insight and clarity. For instance, why does the bottleneck pertain to response selection? Why is mental activity so taxing, and so on. Although these issues are not entirely resolved, Pashler presents some compelling alternatives, corroborating many of these proposals with relevant data.

Second, scattered throughout the book are a series of proposals for future studies. One study is designed to ascertain whether or not feature extraction can be suppressed. A second study concerns the impact of attention on sensory memory. Other studies relate to the pop-out effect, bilevel stimuli, cueing, and also involuntary attention, in which Pashler insightfully discriminates between uncontrolled and suppressible processes, a distinction that resolves some recent uneasiness in this field.

In addition, Pashler is able to explain even the most abstruse ideas in a clear, simple, and engrossing manner, and thus the monograph is appropriate to all cognitive psychologists. Some delightful analogies are utilised to illustrate some of the more vital concepts. For example, to demonstrate the distinction between capacity allotment and statistical noise, Pashler alludes to a contrived murder case in which the police stumble upon a vital tip-off. The police could then confine their resources to those suspects that fulfil the criteria of this tip-off, reminiscent of capacity allotment. Alternatively, all suspects could be scrutinised, and the information could simply impinge on the final decision, a situation that mimics statistical noise.

Although this book is admirably comprehensive, several specific aspects of attention have been eschewed or skimmed, such as inhibition of return, masked priming, neural networks, and also multinomial mixture distributions, which have been successfully invoked to distinguish between the sharing and switching of attention. Some other findings and proposals, such as the significance of synchronous neural firing (Usher & Donnelly, 1998) and the absence of an attentional blink across modalities (Duncan, Martens & Ward, 1997), unfortunately surfaced after the book was first in print. Pashler's comments on these developments could have been invaluable.

In short, this monograph captures the remarkable complexity of attention and cognition, but offers a potential panacea to this confusion. At most, Pashler's theory may resolve most of the paradoxes and uncertainties that have taunted researchers in this area. At least, these proposals will significantly shape the direction of research and attract a new breed of investigators.

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