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Editorial

Attention and short-term memory: Crossroads

Selective attention and short-term memory are staple, core psychological constructs, which have been investigated from the first empirical steps of our discipline (Ebbinghaus, 1885; Helmholtz, 1867/1924). Everyone agrees they are intimately connected, but setting their boundaries and mapping their interrelationships remains challenging. This special issue of *Neuropsychologia* is intended to provide a contemporary and representative snapshot of our scientific endeavours into these old and stubborn puzzles.

Where do we start? 'Definitions' would be a good place, but already we find ourselves in difficult territory. Each construct is used in various ways across the literature. In its narrowest and most accepted sense, 'attention' refers to the set of functions that prioritise information processing according to current task goals and expectations. These functions may involve setting top-down anticipatory signals, which prepare the system for predicted or relevant events – their locations or their constituent features. They also involve selecting the relevant items from the continuous stream of stimulation and inhibiting distractors. Attention-related functions are usually thought to be subordinate to higher-level executive control mechanisms that set, monitor and update the task goals in the first place; though some theorists include these as part of attention.

'Short-term' memory (STM) goes by different labels, and is also known as primary memory (James, 1890) or working memory (Baddeley & Hitch, 1974). It is usually conceptualised as a type of representation – the handful of items that are extracted, or constructed, from the stimulation stream, and which come to occupy our awareness and guide voluntary action. Their maintenance is independent of the original sensory information and resilient against interference.

Therefore, one useful distinction that emerges is that between 'processes' and 'representations'. In a dynamical system like the brain, these are undoubtedly two sides of the same phenomenon. Even though an absolute separation between them is impossible, the two levels of description nevertheless provide a useful categorisation for fuelling empirical and theoretical work. Usually, attention is thought of as a modulatory processes and STM as content representations. However, some theoretical perspectives consider both types of logical descriptors within a given construct. For example, the working-memory model proposes both representational buffers and executive control functions (Baddeley & Hitch, 1974).

What is the nature of the relationship between these two multifaceted constructs? This is the question motivating the special issue. Many kinds of answers are explored in the theoretical and empirical contributions made by scholars active in the field. Rather than converging on one cohesive and dominant view, research to date explores multiple possibilities and continues to enrich our understanding of these constructs individually and as an inseparable couple.

Many contributors to the issue note the commonalities between attention and STM. Both involve the operation of a similar set of multisensory brain areas, in posterior parietal and prefrontal cortices, acting in combination with unimodal sensory areas (see Ikkai & Curtis, 2011; Lepsien, Thornton, & Nobre, 2011; Kuo, Yeh, Chen, & D'Esposito, 2011; Olivers & Eimer, 2011; Cutini, Scarpa, Scatturin, Jolicoeur, Pluchino, Zorzi, & Dell'Acqua, 2011, all this issue). Similar configurations of neural activity are also noted to participate in other, related psychological processes and representations, such as forming motor intentions or mental images (Ikkai & Curtis, 2011; Stokes, 2011, also see Belopolsky & Theeuwes, 2011, all this issue). Attention and STM also share functional properties and limitations (Chun, 2011; Todd, Han, Harrison, & Marois, 2011; Shapiro & Miller, 2011, all this issue), and their markers can co-vary in individuals (Astle & Scerif, 2011; Machizawa & Driver, 2011, all this issue). It is also important to recognise that many experimental tasks that are considered paradigmatic of either attention or STM inadvertently include elements that are typical of both (Stokes, 2011, this issue).

When charting and investigating specific interrelationships between attention and STM, several connections are highlighted. According to one of the most prominent and established theories (Desimone and Duncan, 1995), it is the content of STM that fuels the biasing signals of attention. Different variants of this idea are explored, to consider whether this relationship is necessary, sufficient and obligatory; and to reveal the neural mechanisms involved (Olivers & Eimer, 2011; Soto, Mok, McRobbie, Quest, Waldman, & Rotshtein, 2011; Rotshtein, Soto, Grecucci, Geng, & Humphreys, 2011; Belopolsky & Theeuwes, 2011, all this issue).

Complementing these considerations, many papers also explore the influences of attention upon STM. Modulations at several stages in the information-processing stream are shown to be instrumental in determining the contents of STM. Anticipatory attentional biases are proposed to modulate the initial processing stages of incoming stimulation, and the resulting biasing and selection processes determine what becomes encoded and maintained in STM. Empirical, computational and opinion pieces consider the functional and neural mechanisms at work (Gazzaley, 2011; Murray, Nobre & Stokes, 2011; Bollinger, Rubens, Masangkay, Kalkstein, & Gazzaley, 2011; Bundesen, Kyllingsbæk, & Habekost, 2011, Kyllingsbæk, Geisbrecht & Sy, 2011; Linke, Vicente-Grabovetsky, Mitchell, & Cusack, 2011; Makovski, Swallow & Jiang, 2011, all this issue). The nature of the resulting STM representation, and the role of attention in shaping it, is further considered. For example, there is continued debate about whether STM holds integrated objects within fixed capacity slots or whether the constituent features of objects are maintained

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in a flexible manner within the capacity limits (see Chun, 2011; Luria & Vogel, 2011; Bays, Wu, & Husain, 2011; Shapiro & Miller, 2011; Baddeley, Hitch, & Allen, 2011; Ueno, Mate, Allen, Hitch, & Baddeley, 2011, all this issue). Views also continue to be elaborated on the central issue of how attention regulates what is maintained in the contents of STM (see Cowan, 2011; Olivers & Eimer, 2011, all this issue). Finally, recent work has suggested that modulatory attentional biases can continue to operate upon and influence priorities within internal, STM representations. The mechanisms at work and the theoretical implications of these findings are examined (Lepsien, Thornton, & Nobre, 2011; Vandenbroucke, Sligte, & Lamme, 2011; Sligte, Wokke, Tesselaar, Scholte, & Lamme, 2011; Chun, 2011, all this issue).

So where are we left? Of course it is not up to these editors to have any final word. We merely invite you to browse through the many ideas in the following articles. We leave the reader to make up his or her own mind about how best to understand the continuous cycle through which attention and STM interrelate: how our internal representations in STM help shape the analysis of the incoming flow of sensory stimulation, which in turn determines what will be coded in STM, which in turn shapes perceptual analysis. . .

References

Baddeley, A. D., & Hitch, G. (Eds.). (1974). *Working memory*. New York: Academic Press.
Desimone, R., & Duncan, J. (1995). Neural mechanisms of selective visual attention. *Annual Review of Neuroscience*, *18*, 193–222.
Ebbinghaus, H. E. (1885). *Memory: A contribution to experimental psychology*. New York: Dover.
Helmholtz, H. V. (1867/1924). In JPC, S. (Ed.), Helmholtz's treatise on physiological optics. NY, Rochester (translated from the German).
James, W. (1890). *The principles of psychology*. New York: Dover Publications.

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