1-3 Visual Attention: Knowing about unseen information

An obvious difference between hearing and seeing is that the former is extended in time, while the latter extends over space. So, for example, we can listen to a spoken sentence coming from one place, but it takes some time to hear it all. In contrast, a written sentence is spread over an area (of paper, say) but, as long as it is reasonably short, it can be seen almost instantly. Nevertheless, seeing does require some finite time to capture and analyse the information. This process can be explored by presenting letters or words for a short, measured period of time; nowadays they are shown on a computer screen, but early research used a dedicated piece of apparatus, called a tachistoscope. Just how long was required to register a small amount of information was investigated by Sperling (1960), who showed participants grids of letters, arranged as three rows of four letters each. If such a display was presented for 50 ms (i.e. 50 milliseconds, which is one twentieth of a second), people were typically able to report three or four of the letters; the rest seemed to have remained unregistered in that brief period of time.

Sperling explored this further. He cued participants with a tone, indicating which of the three rows of letters they should try to report; a high note for the top row, lower for middle and deep for bottom. Crucially, the tones were not presented until just *after* the display had disappeared, meaning that participants were not able to shift their attention in preparation for the relevant row of letters when presented: it already had been presented. Strange as it seemed, people were still able to report three or four items from the cued row. Since they did not know until after the display had gone which row would be cued, this result implied that they must have registered most of the letters in *every row*; in other words, between nine and 12 letters in total. This apparent paradox, of seeming to know about a larger proportion of the items when asked only to report on some of them, is called the **partial report superiority effect**. The effect was also observed if letters were printed six in red and six in black ink, then two tones used to indicate which colour to report. Participants seemed to know as much about one half (the red, say) as they did about all 12, implying that, although they could not report all the letters, there was a brief moment when they did have access to the full set and could choose where to direct their attention. The ‘brief moment’ was equivalent to the echoic memory associated with dichotic listening experiments, so the visual counterpart was termed an **iconic memory** (an icon being an image). All the material seemed to be captured in parallel, and for a short time was held in iconic memory. Some was selected for further, serial processing, on the basis of position or colour; these being analogous to position and voice pitch in dichotic listening tasks. Unselected material (the remaining letters) could not be remembered.

With the close parallels between these auditory and visual experiments, you will not be surprised to learn that the simple selection and serial processing story was again soon challenged, and in very similar ways. Where the hearing research used shadowing to prevent conscious processing of material, the visual experiments used **backward masking**. Masking is a procedure in which one stimulus (the target) is rendered undetectable by the presentation of another (the mask); in backward masking the mask is presented after the target, usually appearing in the order of 10–50 ms after the target first appeared. The time between the onset of the target display and the onset of the mask is called the **stimulus onset asynchrony** (SOA). The target might be an array of letters or words; this disappears after a few tens of milliseconds, to be replaced by the mask, which is often a random pattern of lines. The SOA can be adjusted until participants report that they do not even know whether there has been a target, let alone what it was. In such circumstances the influence of the masked material seems sometimes still to be detected via priming effects. Thus, Evett and Humphreys (1981) used stimulus sequences containing two words, both of which were masked. The first was supposed to be impossible to see, while the second was very difficult. It was found that when the second word was related to the first (e.g. 'tiger' following 'lion') it was more likely to be reported accurately; the first, 'invisible' word apparently acted as a prime.

Claims such as these have not gone unchallenged. For example, Cheesman and Merikle (1984) pointed out that although participants say they cannot see masked words, they often do better than chance when forced to guess whether or not one had actually been presented. These researchers insisted that proper conclusions about extracting meaning from unseen material could be made only if the material was truly unseen; that is, when the participants could do no better than chance. Under these conditions they found no evidence for priming by masked words. However, more recently researchers have provided persuasive evidence that meaning *can* be extracted from material of which the participant is unaware. This is worth examining in more detail.

Pecher et al. (2002) used the Evett and Humphreys (1981) technique, but with modifications. As in the earlier study, they showed a potential prime (e.g. 'lion'), followed by a hard-to-see masked target (e.g. 'tiger'). However, there were two changes in this study. First, the priming word could be displayed either for a very short time, so that it was allegedly undetectable, or it was shown for a duration of 1 second, giving ample time for reading and guaranteeing a priming effect.

The second change was to use two sets of trials. In one, the following target was almost always (90 per cent of the time) related to the prime (e.g. 'lion' followed by 'tiger'). In the other set of trials only 10 per cent of trials used related words. For remaining trials the stimuli were unrelated, so that the first word was not strictly a prime (e.g. 'list' followed by 'tiger'). The results of this study are summarised in Table 1.

Table 1 The percentage of targets correctly reported under various priming conditions

	Short duration prime		1 second prime	
	10% related	**90% related**	**10% related**	**90% related**
Related words	56	52	70	91
Unrelated words	49	43	55	51
Priming advantage	7	9	15	40

Source: adapted from Pecher et al., 2002

The effects are best appreciated by looking first at the final two columns of figures, showing the results when the first word was displayed for 1 second. For the condition where only 10 per cent of targets were related to the preceding word, 70 per cent of those targets were correctly identified when there was a relationship. The hit rate fell to 55 per cent when the targets were not related, so the priming effect produced a 15 per cent advantage ($70 - 55 = 15$). The last column shows a massive 91 per cent hit rate for related words, when there was a 90 per cent chance that they would be related to the preceding prime. The priming advantage in this condition has risen to 40 per cent. Why does the benefit of a related prime jump from 15 per cent to 40 per cent when the targets are more likely to be related to the primes? The answer is that, when there is a high chance that they will be related, participants spot the connection and try to guess what the target must have been: they often guess correctly. Notice that they can do this only because the prime word was clearly visible. Look now at the corresponding figures, for when the prime was displayed very briefly. Here the priming advantages (7 per cent and 9 per cent) are far more modest (but statistically significant). However, the important result is that the change from 10 per cent to 90 per cent relatedness does not produce the large increase in the priming effect observed in the 1 second condition. The small increase from 7 per cent to 9 per cent was not statistically significant. It can be concluded that participants were unable to guess in the brief condition, so presumably had not been able to identify the prime words. Nevertheless, those words did produce a small priming effect, so they must have received sufficient analysis to activate their meaning.