

As tasks become practiced, they become more automatic and require less and less central cognition to execute.

The Stroop Effect

Automatic processes not only require little or no central cognition to execute, but they also appear to be difficult to stop from executing. A good example is word recognition for practiced readers. It is virtually impossible to look at a common word and not read it. This strong tendency for words to be automatically recognized has been studied in a phenomenon known as the **Stroop effect** after J. Ridley Stroop who first demonstrated it (Stroop, 1935). The task requires subjects to say the ink color that words are printed in. The word whose ink color they have to name may be a color word like *red* or a neutral word like *bed*. If the word is a color word, it may either be printed in that ink color or in a different ink color. Figure 3.18 shows the results from an experiment by Dunbar and MacLeod (1984). Compared to the control condition of a neutral word, subjects are somewhat faster in the congruent condition of naming the ink color when the word is in the name of that color. They are much slower in the conflict condition at naming the ink color of the word when the word is the name of a different color. That is, for instance, they have great difficulty in saying that the ink

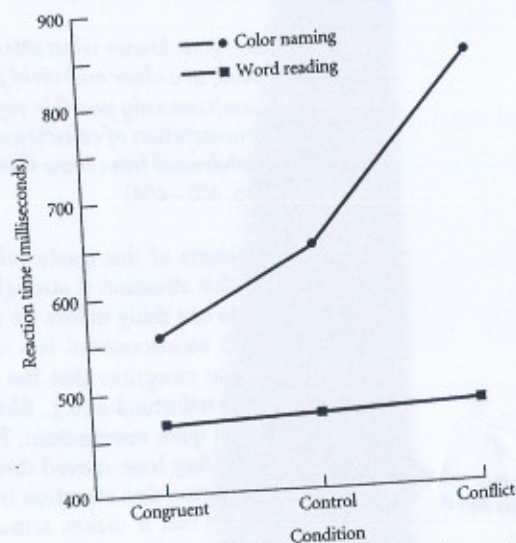


FIGURE 3.18 Performance data for the standard Stroop task. (From Dunbar & MacLeod, 1984.)

FIGURE 3.19 The task is to say aloud the number of characters in each row. This is a variation of the Stroop task. (From Glass & Holyoak, 1986. Reprinted by permission of McGraw-Hill.)

	5	5	5	
1	1	1	1	1
	2			
3	3	3	3	3
	4	4		
	5	5	5	
4	4	4	4	4
5	5	5	5	5
	3			
	4	4	4	
2	2	2	2	2
	3	3		
	4	4	4	
1	1	1	1	1
	3			
2	2	2		

color of the word *red* is green. Figure 3.18 also shows the times subjects took to name the words in these three conditions. The effects are asymmetrical. That is, subjects do not experience the same facilitation or interference in reading the word as a function of its ink color. Of course, they are also much faster at reading a word than naming its ink color, reflecting the highly automatic character of reading.

Subjects are not only much slower at naming the ink color in the conflict condition; they also make many more errors that involve intruding the name of the color word rather than its ink color. Reading is such an automated response that they are often unable to inhibit reading the word, even though they are instructed not to read the word but to say the color. Figure 3.19 presents an analog of the Stroop effect developed by Flowers, Warner, and Polansky (1979) which we can demonstrate in a black-and-white text. You should process it row by row saying as fast as possible the number of characters in each row. You should find it very difficult to resist saying the numbers that make up the row rather than counting the numbers. This is because number recognition is much more automated than counting.

MacLeod and Dunbar (1988) looked at the effect of practice in a Stroop task. They used an experiment in which the subjects had to learn the color names for random shapes. The experimenters then presented the subjects with test geometric stimuli in which subjects had to say either the color name associated with the shape or the actual ink color of the shape. In the original Stroop experiment, there were three conditions:

- **Congruent:** The random shape was in the same ink color as its name.
- **Control:** White shapes were presented when subjects were to say the color name for the shape, or colored squares were pre-

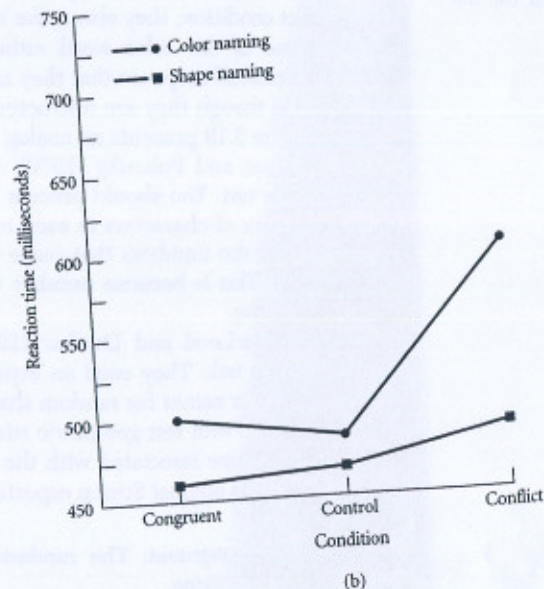
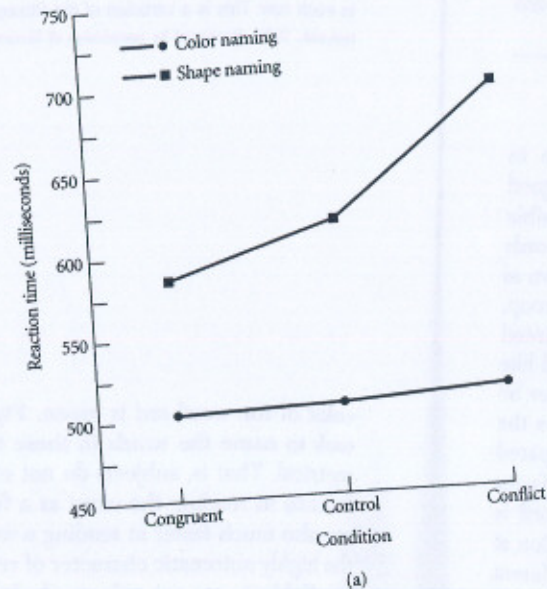


FIGURE 3.20 Data from MacLeod and Dunbar (1988): time required to name shapes and colors as a function of color-shape congruence at (a) initial performance; (b) after 20 days of practice.

sented when they had to name the ink color of the shape. (The square shape was not associated with any color.)

- **Conflict:** The random shape was in a different ink color from its name.

Figure 3.20a shows the results from this task. Color naming was much more automatic than shape naming and was relatively unaffected by the congruence with the shape, whereas shape naming was impacted by congruence with the ink color. Then, MacLeod and Dunbar gave the subjects twenty days' of practice at naming the shapes. Figure 3.20b shows the results then obtained. Subjects had gotten much faster at shape naming, and doing so interfered with color naming rather than vice versa. Thus, the consequence of the training was to make shape naming automatic, like word reading, so that it impacted on color naming.

Reading a word is such an automatic response that it is difficult to inhibit, and it will interfere with processing other information about the word.

Conclusions

There has been a gradual shift in the way the field of cognitive psychology has perceived the issue of attention. For a long time, the implicit assumption of the field was captured by this famous quote from William James (1890) over a century ago:

Everyone knows what attention is. It is the taking possession by the mind, in a clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others. (pp. 403–404)

Two features of this quote reflect once-held conceptions about attention. One is that attention is strongly related to consciousness—that we cannot attend to one thing unless we are conscious of it. The second is that attention, like consciousness, is a unitary system. The field is more and more coming to recognize that the association of attention with consciousness has been unfortunate (e.g., Shiffrin, 1997) since many attentional phenomena seem quite unconscious. For instance, people are often not conscious where they have moved their eyes. Along with this realization has come the realization that attention is not just one factor (e.g., Pashler, 1995). We have seen that it makes sense to separate auditory attention from visual