



The Stroop Task: The “Gold Standard” of Attentional Measures

Colin M. MacLeod

Division of Life Sciences, University of Toronto, Scarborough Campus
Toronto, Ontario, Canada

In 1992, it would be virtually impossible to find anyone in cognitive psychology who does not have at least a passing acquaintance with the Stroop effect. Indeed, this generalization could probably be extended to all those who have taken a standard introductory psychology course, where the Stroop task is an almost inevitable demonstration. Anyone who has had to name the color of the ink in which an incompatible color word is printed (e.g., to say “blue” in response to the word *yellow* printed in blue ink) and who has experienced the unavoidable, stumbling interference that occurs will always remember the experience. The Stroop effect, however, is more than a cognitive curiosity; it continues to play a key role in the understanding of attention.

The Impact of Stroop’s Study

Without question, Stroop’s (1935b) classic article belongs in any collection of influential papers in experimental psychology, and it surely must be among the most cited of the thousands of articles that have appeared in the first century of the *Journal of Experimental Psychology*. More than 700 studies have sought to explain some nuance of the Stroop effect (see MacLeod, 1991a, for a review); thousands of others have been directly or indirectly influenced by Stroop’s article. Together with dichotic listening, the Stroop task is seen both inside and outside cognitive psychology as one of the benchmark measures of attention.

My best guess is that the two most cited articles on cognition in the history of the *Journal of Experimental Psychology* are Stroop’s article on attention and Peterson and Peterson’s (1959) article on short-term memory.¹ A check of the counts in *Social Sciences Citation Index* from its first issue in 1974 to the 1990 issue shows that Stroop has the overall lead on Peterson and Peterson by about 50% (742 to 495), a substan-

tial margin. More revealing is the trend evident in Figure 1. Whereas the Peterson and Peterson article citations diminished considerably over the period, as is common for most articles, the citations for the Stroop study consistently rose, accented by a very recent surge.

Of course, citation counts only indicate how often the article is mentioned, not how often the phenomenon is the subject of direct research interest. This potentially more telling information can be gleaned from the reference section in my review article (MacLeod, 1991a). Between 1935 and 1964, 16 articles are cited that directly examined the Stroop effect: Stroop’s own article, Thurstone’s (1944) article, and a small flurry of studies between 1958 and 1963. It is perhaps not surprising that this 30-year gap coincides with the height of behaviorism. After 1964, the annual number of such studies rose quickly, until by 1969 the number of articles settled in at just over 20 annually, where it appears to have remained.²

Clearly, then, the Stroop effect is a well-known attentional phenomenon. It is also a frequently used index of attention and, of particular concern, a topic of continuing research interest in its own right. Why is the Stroop effect so popular? No doubt there are a number of reasons, but two are particularly crucial. First, the effect is large and always statistically reliable, a feature of considerable comfort from an empirical standpoint. Second, in the 57 years of its existence, the Stroop effect has never been adequately explained, making it a source of continuing theoretical fascination.

In introducing a study of such historical and contemporary significance as Stroop’s (1935b), it would seem appropriate to provide some sense of the person behind the classic study and to provide a sketch of the history of the problem he studied. These are the two purposes of the remainder of this article.

Preparation of this article was supported by Natural Sciences and Engineering Research Council of Canada Grant A7459. I am grateful to Fred Stroop and to the late Zelma Stroop for their assistance with the biographical information. I also thank Walter Schneider, Jonathan Schooler, and Judith Shedden for their comments on a previous version.

Correspondence concerning this article should be addressed to Colin M. MacLeod, Division of Life Sciences, University of Toronto, Scarborough, Ontario, Canada M1C 1A4. Electronic mail may be sent to macleod@lake.scar.utoronto.ca.

¹ White (1983) included Peterson and Peterson (1959) as one of only five *Journal of Experimental Psychology* articles among his 50 most prominent publications in cognitive psychology. Two of the five were sets of norms; the other two were articles published immediately before White’s target period (1979–1982). Oddly, he omitted Stroop (1935b), despite Stroop having a higher citation count than did Peterson and Peterson in the target period.

² As the review does not cover all of the work done between 1989 and the present, it is not possible to ascertain whether the same sharp rise shown in Figure 1 is also evident in the studies directly examining the Stroop effect.

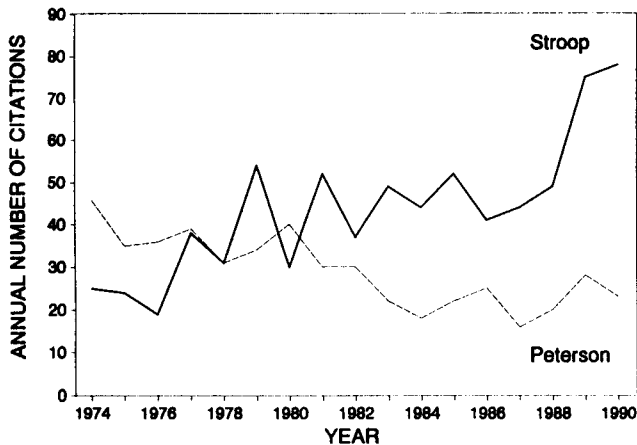


Figure 1. The annual frequency of citation of the Stroop (1935b) and Peterson and Peterson (1959) articles from 1974 to 1990 inclusive (derived from the *Social Sciences Citation Index*).

John Ridley Stroop: The Man Behind the Task

Before considering the history and impact of the task, I begin with a brief biography of Stroop; a more extensive biographical note can be found in MacLeod (1991b). I do this because it is my impression that knowing about the researcher often animates the research.

John Ridley Stroop was born near Murfreesboro, Tennessee, on March 21, 1897. His middle name derived from a preacher whom his parents admired, and Stroop was known by that name both personally and professionally throughout his life. The second youngest of six children, Stroop was not expected to live through infancy, so he was sheltered as a child on the family farm.

Stroop graduated at the top of his elementary school class in Kitrell County School, then continued his education in nearby Nashville, his home for almost his entire life. Most of his later education and virtually all of his academic career centered around David Lipscomb College (now David Lipscomb University) in Nashville. He graduated from David Lipscomb High School in 1919 and obtained a diploma from David Lipscomb Junior College in 1921, where he was selected to be valedictorian.

Stroop's university years were spent at George Peabody College (now part of Vanderbilt University) in Nashville. There, he received his BS in 1924, his MA in 1925, and his PhD in 1933. The doctoral degree was in experimental psychology with a minor in educational psychology and an elective in education. Stroop's (1935b) classic article was his dissertation, supervised in the Jesup Psychological Laboratory by Joseph Peterson, a former president of the American Psychological Association. Stroop developed his task partly because the naming-reading comparison was of interest to Peterson in his individual-differences research (see, e.g., Peterson, Lanier, & Walker, 1925). Stroop's intellectual debt to Peterson is evident from the author note and introduction to his classic paper.

Just before commencing university, at the age of 24, Stroop married Zelma Dunn, great niece of David Lipscomb. During

his university years, they had three sons. Stroop built a house for his family and continued to teach at David Lipscomb College while in the graduate program at George Peabody College. He also taught high school and worked as a janitor and as a librarian to help support his family.

On completing his PhD, Stroop accepted a faculty position at David Lipscomb College, where he taught for almost his entire 40-year career. His plan to collaborate with Joseph Peterson ended when Peterson died, and it was probably this event more than any other that led Stroop to discontinue his psychological research. In his career, he published just four papers, one concerning group versus individual judgments in 1932, and three related to color-word processing—the classic paper (Stroop, 1935b), a critique of work on the color-word issue (Stroop, 1935a), and a test of a possible explanation of the Stroop effect (Stroop, 1938).

Although he remained in psychology, and indeed chaired his department from 1948 until 1964, he never again conducted research in the field. Instead, he devoted his attention to his religion for the rest of his life. Stroop was a devout Christian who preached every Sunday in and around Nashville. At David Lipscomb College, he taught Bible classes as well as his psychology classes. Known both as Doctor Stroop and as Brother Stroop to his colleagues and students, he was considered one of the best teachers at the college. At a personal level, he was esteemed as a good and intelligent man with a strong sense of fairness and a dry sense of humor.

Stroop wrote seven books based on his biblical teachings (see Maiden, 1973). This series began with *Why Do People Not See the Bible Alike?* (1949) and ended with *Restoration Ideas on Church Organization* (1966). His major work, a trilogy entitled *God's Plan and Me*, was published in the 1950s. He received awards for these books, which were popular as textbooks in Christian schools. Quite clearly, the Bible, not psychology, was Stroop's life work. When Jensen and Rohrer contacted Stroop in preparing their 1966 review, he expressed little interest in the task he had created. When he retired in 1967, he stayed on as Emeritus Professor of Biblical Studies. He died in Nashville on September 1, 1973, at the age of 76.

Naming and Interference: A Brief History

The issue Stroop chose to investigate in his doctoral dissertation is at least as old as experimental psychology. In fact, it was imported from philosophy into psychology by James McKeen Cattell (1886) for his own dissertation, which was supervised by Wilhelm Wundt. Cattell reported that it was faster to read words aloud than it was to name the corresponding objects or their properties (including color) aloud. He interpreted this speed difference—in extraordinarily modern terms—as evidence that extensive practice made reading “automatic,” but that considerably less practice left naming “voluntary.” The first section of my review (MacLeod, 1991a) described the series of studies that pursued this fundamental reading-naming contrast in the 50 years between Cattell and Stroop.

Although Stroop came to his famous task from the direction of his supervisor's interest in naming versus reading, his own

interest was clearly not in this contrast but in what happened when the two task dimensions co-occurred. Surprisingly, he was the first to ask this now very obvious question.³ Unlike his predecessors, it was the interference that Stroop observed that was the focus of his study, and it is also the basis for subsequent interest in the task that now bears his name.

As mentioned earlier, virtually no further experimental investigations of the Stroop effect occurred for the 30 years after Stroop's dissertation.⁴ As I see it, the impetus for its reemergence was a critical study by Klein (1964). Basically, what Klein showed was that interference in color naming was an orderly function of the degree of relation of the irrelevant word to the ink color response (e.g., *green* interferes more with saying "red" than *horse* does). This observation led to increased interest in the underpinnings of the interference as well as to increased use of the task as a measure of attention in cognitive studies.

Since the emergence of the automatic-controlled distinction (Posner & Snyder, 1975; Shiffrin & Schneider, 1977), the Stroop task has gained its greatest prominence. In large part, this is because it appears to pit an automatic process (word reading) against a controlled process (color naming), offering a fertile testing ground for this distinction. Additionally, the movement of cognitive psychology away from serial models and toward parallel models has led researchers to focus on situations like the Stroop task where multidimensional stimuli must be processed under attentional control. It seems likely that research involving the Stroop effect will continue to grow for the foreseeable future. Over a half century after Stroop's

pioneering work, the task that bears his name continues both to serve and to challenge cognitive psychology.

References

- Cattell, J. M. (1886). The time it takes to see and name objects. *Mind*, *11*, 63–65.
- Jaensch, E. R. (1929). *Grundformen menschlichen Seins* [Foundations of basic forms of human existence]. Berlin, Germany: Otto Elsner.
- Jensen, A. R., & Rohwer, W. D., Jr. (1966). The Stroop color-word test: A review. *Acta Psychologica*, *24*, 398–408.
- Klein, G. S. (1964). Semantic power measured through the interference of words with color-naming. *American Journal of Psychology*, *77*, 576–588.
- MacLeod, C. M. (1991a). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, *109*, 163–203.
- MacLeod, C. M. (1991b). John Ridley Stroop: Creator of a landmark cognitive task. *Canadian Psychology*, *32*, 521–524.
- Maiden, L. (1973). Obituary: J. Ridley Stroop. *Gospel Advocate*, October 25, 682–683.
- Peterson, J., Lanier, L. H., & Walker, H. M. (1925). Comparisons of white and negro children in certain ingenuity and speed tests. *Journal of Comparative Psychology*, *5*, 271–283.
- Peterson, L. R., & Peterson, M. J. (1959). Short-term retention of individual verbal items. *Journal of Experimental Psychology*, *56*, 193–198.
- Posner, M. I., & Snyder, C. R. R. (1975). Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola Symposium* (pp. 55–85). Hillsdale, NJ: Erlbaum.
- Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending and a general theory. *Psychological Review*, *84*, 127–190.
- Stroop, J. R. (1932). Is the judgment of the group better than that of the average member of the group? *Journal of Experimental Psychology*, *15*, 550–562.
- Stroop, J. R. (1935a). The basis of Ligon's theory. *American Journal of Psychology*, *47*, 499–504.
- Stroop, J. R. (1935b). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643–662.
- Stroop, J. R. (1938). Factors affecting speed in serial verbal reactions. *Psychological Monographs*, *50*, 38–48.
- Thurstone, L. L. (1944). *A factorial study of perception*. Chicago: University of Chicago Press.
- White, M. J. (1983). Prominent publications in cognitive psychology. *Memory & Cognition*, *11*, 423–427.

³ Jensen and Rohwer (1966) point out that Jaensch (1929) actually predated Stroop in combining the two dimensions as part of a monograph. Perhaps the fact that Stroop's study is exceptionally elegant, both in design and presentation, contributed to his greater impact. Surely publishing it as a lead article in the *Journal of Experimental Psychology* also helped to make Stroop's study much better known!

⁴ Numerous studies, however, had used the Stroop task as an attentional index; Jensen and Rohwer (1966) reviewed many of these.