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Commentary

Hypnotic control of attention in the Stroop task: A historical footnote

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Abstract

Raz, Shapiro, Fan, and Posner (2002) have recently provided a compelling demonstration of enhanced attentional control under post-hypnotic suggestion. Using the classic Stroop (1935) color-word interference paradigm, in which the task is to ignore a word and to name the color in which it is printed (e.g., RED in green, say “green”), they gave a post-hypnotic instruction to participants that they would be unable to read. This eliminated Stroop interference in high suggestibility participants but did not alter interference in low suggestibility participants. Raz et al. (2003) replicated this pattern and further demonstrated that it is not due to a visual strategy (such as blurring or looking at a different location). As a historical footnote, we describe a “case study” from 18 years ago in which we observed the same result using a hypnotic instruction to a single highly suggestible individual that he could not read. The elimination of Stroop interference has important implications for both the study of attention and the study of hypnosis.

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1. Introduction

In the realm of cognition, the study of attention is in ascendancy. If attention is the “cognitive gatekeeper,” then our understanding of its operation will influence our entire conception of cognition. How do we successfully select certain information for further processing out of the rich

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flow of experience, disregarding the rest? One way to address this question is to invert it: under what conditions do we fail to select optimally? Of all such non-optimal situations, undoubtedly the best known is the classic *Stroop effect* (Stroop, 1935).

In the standard Stroop procedure, participants name the colors of printed items, saying “blue” to the word RED in blue (incongruent condition) and “green” to the non-word “xxxx” in green (control condition). Optimal performance would occur if the irrelevant word dimension had no influence whatsoever on the relevant color dimension. In fact, though, the word has a substantial effect, slowing color naming and producing *Stroop interference* (incongruent–control). There is now a voluminous Stroop literature (see MacLeod, 1991; MacLeod & MacDonald, 2000).

Stroop interference reveals the extreme difficulty of ignoring the word. Apparently, a more practiced dimension is more automatically processed. This idea goes back to Cattell (1886), and has been empirically confirmed (e.g., MacLeod & Dunbar, 1988) and modeled in a connectionist framework (Cohen, Dunbar, & McClelland, 1990). When that more automatically processed dimension must be ignored, attention is compromised: the more automatic word reading skill cannot be “turned off” despite directions to attend solely to the print color (cf. Posner & Snyder, 1975). The result is a conflict between the two dimensions that is difficult to resolve, negatively affecting color naming latency and accuracy.

Stroop interference is a large effect. When the response is oral color naming, incongruent trials can be 100–200 ms slower than baseline. Compare this to the effect sizes of semantic priming or negative priming, typically around 20 ms. Stroop interference is also highly robust: anyone who can read shows a decrement in the incongruent condition. Indeed, despite the huge literature, claims to entirely eliminate Stroop interference are rarely reported and, when they are, the studies often have deviated significantly from the standard Stroop procedure.

2. Eliminating Stroop interference via post-hypnotic suggestion

It is intriguing, then, that Raz et al. (2002) have recently reported the complete elimination of Stroop interference. They hypnotized individuals of high vs low suggestibility. Under hypnosis, participants were given a post-hypnotic instruction—to be activated by a cue after hypnosis was “lifted”—that they would be unable to read and that the letters would look like a foreign language. Low suggestibility individuals continued to show normal Stroop interference under this suggestion. But for high suggestibility individuals, Stroop interference vanished. Raz et al. (2003) have replicated this pattern, showing that this dramatic change is not due to a visual strategy.

The results of Raz et al. (2002, 2003) suggest a genuine ability to ignore the irrelevant words under post-hypnotic suggestion, something that people cannot do ordinarily, even after extensive practice and given considerable effort (MacLeod, 1998). Attention would appear to be more adjustable under hypnosis than is normally possible, suggesting that hypnosis may be useful for examining the limits of attentional control, as Raz and Shapiro (2002) cogently argue. The fact that hypnosis can eliminate such a robust phenomenon is testament to its efficacy and its cognitive relevance. Consequently, we see the results of Raz et al. as important and compelling.

3. A “Prequel”

This note was prepared to complement the recent Raz et al. (2002, 2003) findings. In a discussion with the first author (CMM), Raz was intrigued to discover that we had begun a very similar project 18 years ago. After consultation with the second author (PWS), the three of us agreed that it would be interesting to provide an account of those early efforts. We emphasize that this account should be seen as a historical footnote. The idea of examining the relation between Stroop interference and hypnosis did not originate with us: Blum and Graef (1971) showed more interference under hypnosis in high suggestibility than in low suggestibility individuals (see also Dixon & Laurence, 1992; Dixon, Brunet, & Laurence, 1990; in contrast, see Nordby, Hugdahl, Jasiukaitis, & Spiegel, 1999). We extended this pattern (Sheehan, Donovan, & MacLeod, 1988), showing that, relative to the normal waking state, interference increased under hypnosis particularly for high suggestibility individuals. But these studies did not directly manipulate instructions to participants.

The central idea of the approach taken by Raz et al. (2002, 2003) was to manipulate the instructions, telling participants that upon a cue they would be unable to read because the written words would appear to be in a foreign language. The goal was to eliminate interference because the now unrecognizable, unreadable words could not interfere. And this was exactly what they observed in high suggestibility participants.

Eighteen years ago, in the academic year 1984–1985, CMM was on sabbatical at the University of Queensland in Brisbane, Australia, where PWS was a faculty member. Having discussing our respective interests, we decided to embark on a study of attentional control in the Stroop task under hypnosis. The manipulation we settled on was to instruct participants under hypnosis that they could not read. We anticipated that, if hypnosis was a sufficiently powerful controller of attention, then interference should be reduced or perhaps even eliminated.

The account that follows has been assembled from notes and files constructed at the time of our collaboration, together with our recollections. The primary sources are (1) the script of a research talk given by CMM in the “Ebbinghaus Empire” at the University of Toronto on September 18, 1985, just after the sabbatical, (2) printouts of data files from the single individual tested on February 19, 1985, and (3) procedural details which were similar to those reported by Sheehan et al. (1988).

The talk script identifies the motivating question as “are there any factors that can reduce or eliminate Stroop interference?” “After considerable discussion, we settled on the instruction to be unable to read, and to use the Kahneman and Chajczyk (1983) version of the Stroop task with color bar above color word. We considered a negative visual hallucination instruction (cannot see the word), but thought the reading instruction more suitable. We also decided to do the study with both the Kahneman and Chajczyk and the Stroop versions of the task.” This distinction refers to the separated vs integrated versions of the task (see MacLeod, 1998). We began with the separated version, which typically shows smaller interference, to give our initial attempt the best chance of succeeding. We would then “plan to run three groups on each version of the task: (1) high susceptible, (2) normal, and (3) simulator.”

As it happened, the planned study was never carried out, despite efforts on both our parts over the ensuing years. In fact, though, one participant was tested, with promising results. Our eagerness to test more participants was stymied by an unfortunate event: Queensland power workers

staged a strike, leaving the entire state—and our computers—without electricity for two weeks, by unhappy coincidence CMM's last two weeks in Queensland.

4. Method

4.1. Participant

The participant was a “somnambulist” (highly hypnotizable) individual known to PWS from prior studies. Born in Germany, this individual switched from English to German when, in the preliminary phase, PWS age regressed him earlier than about age 10. He sat with PWS and CMM in a dimly lit room in a comfortable chair.

4.2. Materials and apparatus

The experiment was carried out on a BBC microcomputer with a color monitor, programmed in BASIC with timing routines permitting 1 ms resolution from responses into an interfaced microphone. The print colors and words were RED, BLUE, GREEN, and YELLOW; the control string was XXX.

4.3. Procedure

The design of the experiment was to involve six blocks of Stroop trials: “(1) practice/baseline, (2) baseline, (3) task motivated (i.e., hypnotic instructions without induction), (4) baseline, (5) hypnotized, and (6) baseline.” The goal was “collecting lots of baseline data around key blocks (to watch for practice effects, etc.).” The notes also indicate that “we lost the last block due to a power failure.”

To describe block configuration, “Each block was made up of 96 trials, 32 per condition . . . conditions were randomized.” The three conditions were congruent (e.g., RED in red, say “red”), incongruent (e.g., BLUE in red, say “red”), and control (e.g., XXX in red, say “red”). The congruent condition was included because one possible strategy for eliminating Stroop interference in a study using only incongruent and control trials would be to selectively slow down in the control condition. The congruent condition would reveal such a strategy because abnormally large facilitation would result.

Details about precise trial timing no longer exist, but there was a brief blank screen (less than a second) between trials, and the color bar plus word stimulus remained on the screen until the participant responded into the microphone. The color bar was about the same height as the word was presented above the word (printed in white) at the center of the screen.

5. Results

Table 1 presents medians, not means, for each condition because there was only one participant. However, the means showed a very similar picture. Recall that our task was the separated

Table 1

Median response times in milliseconds and proportions of errors (in parentheses) as a function of experimental block

Block	Condition			Difference scores	
	Congruent	Incongruent	Control	Facilitation	Interference
Practice 1	576 (.000)	722 (.156)	612 (.000)	36	110
Practice 2	528 (.062)	599 (.031)	521 (.031)	-7	78
Instructions only	628 (.031)	739 (.062)	702 (.094)	74	37
Practice 3	512 (.031)	602 (.062)	509 (.031)	-3	93
Hypnosis + instructions	638 (.000)	651 (.075)	653 (.111)	15	-2

version with vocal responding. Relative to the integrated version with button press responding used by Raz et al. (2002, 2003), ours should produce similar effects, with interference increased by switching to vocal responding but decreased by switching to the separated version.

Consider the three baseline blocks. The derived scores of facilitation (control–congruent) and interference (incongruent–control) decreased between the first and second practice blocks and then roughly stabilized (compare Practice 2 to Practice 3). This pattern is typical of such data; in particular, facilitation usually is less reliable than interference and sometimes is not significant (see MacLeod, 1991, 1998). In the third block, when given just the instructions about being unable to read but without hypnotic induction, the participant appears to have tried to adjust his strategy, principally by slowing down his control condition. This resulted in reduced interference but increased facilitation. The total congruency effect of 111 ms remained, however, like those in the surrounding two practice blocks (71, 90 ms), and was certainly not smaller.

The impressive result is evident in the hypnosis plus instruction block. Here, interference vanished, and facilitation was minimal.¹ Had the participant attempted to use a strategy similar to that used in the instructions-only block, he would have displayed decreased interference but increased facilitation. Instead, both difference scores fell close to zero.

6. Discussion

Raz et al. (2002, 2003) have reported two compelling data sets showing that a *post-hypnotic* instruction to be unable to read can eliminate Stroop interference in high suggestibility participants, using the integrated, button pressing task version. Our results suggest that the same pattern occurs for an instruction given *during hypnosis*, using the separated, vocal task version. Of course,

¹ A peculiar change occurred in the hypnosis plus instruction block: the participant named all instances of yellow as “green,” despite not having had any apparent difficulty discriminating the colors yellow and green prior to this block. We have, therefore, considered all trials where the color yellow was responded to as “green” to be correct responses, adjusting the condition assignment accordingly. Removing the yellow trials results in a very similar pattern.

the usual cautions about single-case studies apply to our study. But our results do suggest that generalizing the Raz et al. studies would be worthwhile, as they no doubt will do.

What is striking about their results is the complete elimination of Stroop interference, a finding rarely reported using the standard version of the task (but see Melara & Algom, 2003). One implication is that hypnosis is a very effective way to control attention, given its dramatic impact on such an ordinarily robust effect. Eighteen years ago, we considered several other questions worth pursuing, including instructing participants (1) that they could read the words RED and BLUE but not the words GREEN and YELLOW, such that interference should be present only for the former set, or (2) that each of the print colors would appear to be another color (e.g., red would appear blue, green would appear yellow) such that the congruency of the conditions would be redefined. The elegant work of Raz and his colleagues opens up these and many more possibilities, and we look forward to new developments in their impressive program.

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