Cue based switching between color-naming and word-reading responses to Stroop stimuli: Symmetric interference and complete disappearance of the Stroop effect

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Abstract

The asymmetry of the interference effect in the Stroop phenomenon is well known; Color-naming of incongruent color-words is damaged by word-dimension to be read, while in contrast with it, word-reading of incongruent color-words is not damaged by color-dimension to be named. We carried out five experiments on switching tasks between color-naming and word-reading based on tone cues (Exp.1) and based on color-words primes (Exp.2 to 5) . The participants had to make responses through word-reading to Stroop stimuli when tone cues as prime stimuli were higher pitched, while through color-naming to them when tone cues were lower pitched (Exp.1). Consequently, we found the disappearance of the asymmetry of the incongruence effect. Experiments from Exp.2 to Exp.5 involved cues as color-words but not tone cues. We obtained the complicated findings; "complete disappearance of the Stroop effect" and "symmetric interference effect" in differnet conditions when primes as switching-cues did not include color-words of targets (Exp.2) in contrast to this finding of Exp.1. Thus we carried out furthermore three experiments (Exp.3 to Exp.5) in varied relationships between primes and targets. Even when primes as switching cues did not include color-words of targets, large memory sets of cues made "complete disappearance of the Stroop effect".

We carried out four experiments on task switching based on priming cues of color naming.In four experiments, participants made switching of responses between color-naming and word-reading through vocal responses to Stroop stimuli. These experiments consisted of different components of independent variables different each other (SOA between primes and targets, attributes of prime, and the relationship between primes and targets). Exp.1 included tone primes as switching cues and Exp.2, 3, 4 and 5 included color-words primes as switching cues.

Method

Apparatus and stimuli

These four experiments were conducted using computers running E-Prime software (Version 1.1; Psychology Software Tools, 2002).

Subjects

Ninety two students from Kobe University completed the experiments either in exchange for course credit or in voluntary act (n=4 in Exp.1; n=16 in Exp.2; n=24 in Exp.3; and n=24 in Exp.4; n=24 in Exp. 5).

Procedure

Subjects performed the tasks in private sound-proof rooms through wireless LAN connected

with the control PC in the next room in five experiments. Each trial consisted of a target word printed in one of three colors: red, blue, or green in Exp.1 and in one of four colors: red, blue, green or yellow in Exp.2, 3, 4 and 5. Congruent target-stimuli consisted of one of the four color names presented in its own color. The incongruent target-stimuli consisted of one of the three or four color names presented in one of the two or three remaining colors. Priming stimuli cuing of switching tasks (color-naming or word-reading) consisted of high or low pitched tone in Exp.1. Exp.1 included three dimensions of conditions which consisted of a) variable SOAs between primes and targets (-150 ms, -50 ms, 50 ms, and 150 ms) between blocks, b) congruent or incongruent color-words as targets within blocks, and c) the kind of tasks (word-reading or color-naming) within blocks.

In Exp.2 to 5, priming stimuli cuing of switching (color-naming or word-reading) consisted of color-words. Participants had to make vocal responses in a way of switching between color naming and word reading in each trial when the specific color or word dimensions of priming stimuli occurred. In Exp.2, priming stimuli consisted of either color-words which included colors and words of target-stimuli (red, blue, green, or yellow) or did not include color and words of target-stimuli (white, black, brown, or pink). Exp.2 included five dimensions of conditions; a) variable SOAs between primes and targets (200 ms and 400 ms) between blocks, b) congruent or incongruent color-words as targets within blocks, c) the relationship between primes and targets (primes included color-words of targets or not) between blocks, d) the kind of tasks (word-reading or color-naming) within blocks, and e) attentional dimensions (color or word) between blocks. Participants had to make focused attention into either color or word dimension of color-word primes. In the condition of color dimensional attention, participants had to switch between word-reading and color-naming according of color dimension of prime. For example, in one trial, they make response through word-reading when color dimensions of prime included either white or blown (when primes did not include color of targets), or in other ways, they make response through color-naming when color dimensions of prime included either red or yellow (when primes included color of targets). In other trails they make response through color-naming when word dimensions of color-word primes included either black or pink (when primes did not include color of targets), or in other way, they make response through word-reading when color dimensions of prime included either blue or green (when primes included color of targets). However, in one way, the participants got instruction which said that they should make response through color-naming when color dimensions of prime included white, brown, red or yellow, because response mode varied between blocks. In the other way, the participants got instruction which said that they should make response through word-reading when word dimensions of prime included black, pink, blue or green.

Exp.3 included conditions which consisted of fixed SOA (400 ms) and color-words-primes including ones of targets (e.g., red, green, blue, or yellow). Exp.4 included conditions which included of fixed SOA (400 ms) and color-words-primes including no ones of targets (e.g., white, black, brown, or pink).Both Exp.3 and Exp.4 included commonly three dimensions of conditions; a) congruent or incongruent color-words as targets within blocks, b) the kind of tasks (word-reading or color-naming) within blocks, and c) attentional dimensions (color or word) within blocks. In condition of color as attentional dimensions, the participants make response through word-reading when color dimensions of primes included either red or yellow in Exp.3 (where primes included color of targets), or in other way, when color dimensions of primes included either white or brown in Exp.4 (where primes did not included color of targets). In contrast to it, in condition of word as attentional dimensions, the participants make response through word-reading when word dimensions of primes included either green or blue in Exp.3 (where primes included color of targets), or in other way, when word dimensions of primes included either black or pink in Exp.4 (where

primes did not included color of targets).Exp.5 consisted of mixture of conditions in both Exp.3 and Exp.4. These conditions consisted of “between blocks” tasks.

Results and Discussion

Fig.1 and Fig. 2 show the average reaction times (RTs) in both conditions of word-reading and color-naming in Exp.1. Analysis of variance (ANOVA) with three within-subjects (repeated) factors revealed two main significant effects; {main effect A [$F(3,1755)=54.286$, $p<.01$] and main effect B [$F(1,1755)=135.01$, $p<.01$]} and one non-significnat effect C [$F=(1,1755) = 2.581$, n. s.] Main effect A is involved in SOAs, main effect B is involved in congruency of color-words as targets, and main effect C is involved in the kind of tasks (between word-reading and color-naming). It is established extensively that larger RTs to incongruent than to congruent color-words exclusively in color-naming as response mode are always obtained in the Stroop experiment (i.e.; asymmetric interference in the Stroop effect).

However, we find the evidence that this phenomenon disappears; that is, the interefence occurs commonly in both color-naming and word-reading when participants must switch between word-reading and color-naming in each trial according tone cues. We call this phenomenon ”symmetric interference in the switching Stroop task based on tone cues”. These findings are similar to ones of Shimada’s Exp.4 (1994).

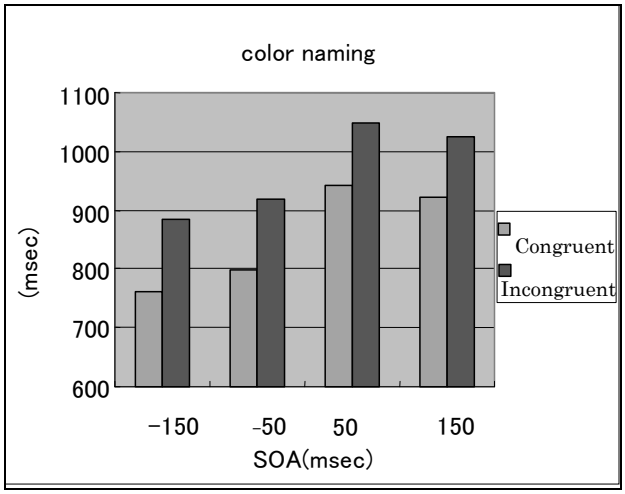

Fig.1 Reaction times in color naming in Exp.1

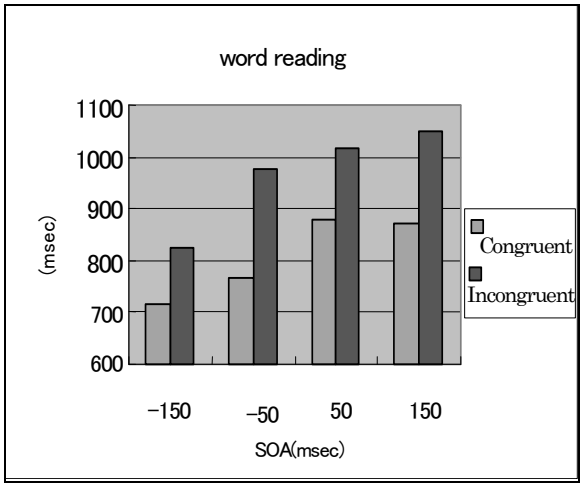

Fig.2 Reaction times in word reading in Exp.1

Experiments from Exp.2 to Exp.5 involved cues as color-words but not tone cues.Exp.2 revealed the extremely different results cased by the relationship between primes and targets (primes included color-words of targets or not) within blocks. When primes as switching-cues included color-words of targets, we obtained ”symmetric interference in the switching Stroop task” in color-word primes as well as in tone cues (Exp.1). However, in contrast to this finding, we obtained ”complete disappearance of the Stroop effect” when primes as switching-cues did not include color-words of targets.

We carried out three furthermore experiments, in which each includes exclusively one condition on the relationship between primes and targets. Exp.3 involved color-words-primes including ones of targets (e.g., red, green, blue, or yellow), and in contrast with that, Exp.4 involved color-words-primes including no ones of targets (e.g., white, black, brown, or pink). Analysis of variance (ANOVA) with three within-subjects (repeated) factors revealed three main significant effects; main effect A [$F(1, 2386)= 307.6636$, $p<.001$], main effect B [$F(1, 2386)= 38.4348$, $p<.001$], and main effect C [$F(1, 2386)= 23.1723$, $P<.001$].

Main effect A is involved in congruency of color-words as targets, main effect B is involved in attentional dimensions (color or word), and main effect C is involved in the kind of tasks (between word-reading and color-naming). The interaction effects except A x B were non-significant. Thus the kind of tasks (bewteen word-reading and color-naming; main effect C) had the same interference effect on both congruent and incongruent Stroop stimuli. We obtained the evidence that the symetric interference effect occured when color-words-primes included ones of targets (e.g., red, green, blue, or yellow), and furthermore in 400 ms as SOA between primes and targets. In simmilar to Exp.3, Exp. 4 revealed the symmetric interference effect. Analysis of variance (ANOVA) with three within-subjects (repeated) factors revealed three main significant effects; main effect A [$F(1, 2386)= 336.44$, $P<.001$], main effect B [$F(1, 2386)= 93.56$ $p<.001$], and main effect C [$F(1, 2386)= 18.59$, $P<.001$]. Thus, even when primes as color-words including no color-words in targets coourred, the symmetric interference effects occured. In contrast with Exp.4, Exp.5 revealed the extremely different results; esspecially the dissaperance of symmetric interference in the condition which consisted of condition in Exp.4 as one of ”between blocks”.

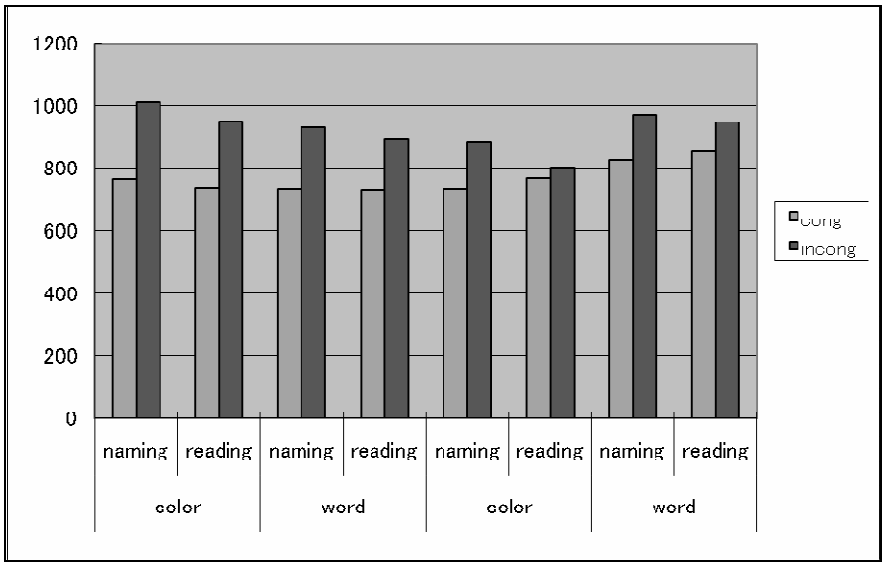

Fig.3 Average RTs in Exp.5

We obtained ”complete disappearance of the Stroop effect” in certain condition in Exp.2, ”symmetric interference” in Exp.4, ”disappearance of the Stroop effect” in Exp.5. These findings occured in the conditions involved color-words-primes including no ones of targets. However, memory set of cues for switching task varied in Exp.2; four (e.g., white, brown, red, and yellow), Exp.4 and 5; two (e.g., white and brown). Even when primes as switching cues did not include color-words of targets, large memory sets of cues made ”complete disappearance of the Stroop effect”.

References

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