Does age affect the stroop effect?

This paper considers the Stroop task and asks whether broad demographic characteristics like gender and age can influence interference. Previous studies have found that interference does increase with age because the cognitive capacities required to suppress the more automatic response begin to decline. However, the findings with regard to gender are more equivocal, with some studies finding differences and others, not. In particular, the recent study by Van der Elst et al (2006), which had almost 2, 000 participants, found that women showed less Stroop interference. However, results from the present study show the opposite effect, with men showing significantly less Stroop interference than women. No significant main effect of age was found, though there was a non-significant trend in the predicted direction, which suggests that this could be due to sample size.

Introduction

The Stroop effect was first observed by John Stroop (1935) with his demonstration of interference in the reaction time of a task but originated in work done by Cattell (1885). There appeared to be an inability to ignore a colour word when the task is to report the ink colour of that word. Stroop found as the test reaction time of participants decreased, mistakes increased. This interference was explained by the automation of reading, where the mind automatically determines the semantic meaning of the word, and then must override this first impression with the identification of the colour of the word, a process which is not an automatic process. Stroop used these findings to suggest that many language processes are automatic and unavoidable. Subsequently, the effect has been used to illustrate that other types of inputs can interfere with each other. Shiffrin & Schneider (1977) used a kind of Stroop effect to illustrate that practice can lead to automatic processing, and inputs being processed in a different way. This has implications for attention because it is argued that automatic tasks use up little processing power, so are more readily combined with other activities. Automatic processes are unavailable to consciousness and require little processing capacity.

The Stroop Test has proven an assessment tool within psychology that is both reliable and useful, Lezaket et al (2004). Numerous variations on the Stroop task have been devised over the years for example, Trenerry et al (1989); Golden (1978); Comalli et al (1962); which involve variations in the number and colour used for the test items, as well as the number of subtests, and method of administration. Nonetheless, the basic paradigm has remained unchanged. The participant's performance in carrying out a basic task such as reading the names of colours compared with their performance on a similar task in which an automatic response must be suppressed and an unusual one expressed, such as naming the colour of the ink that a differently named colour word is printed in. The difference in latency between the latter task and the basic task is known as the interference effect, Moering et al (2004). Some even see this effect as an index of general cognitive control and flexibility, Ivnik et al (1996) that declined with age and it has even been used in some clinical conditions for example Davidson et al (2003). With regards to gender, some studies have reported differences Hameleers et al (2000); Van Boxtel et al (2001); Moering et al (2004) but some have found no differences, Swerdlow et al (1995); Klein et al (1997); Trenerry et al (1989) and Houx et al (1993).

Demographic features also have a role to play in the Stroop task. Van der Elst et al (2006) gave a Stroop test to a large sample of 1, 856 participants with normal cognition function across the adult age range (24 – 81), with differing levels of education. They found that gender had a clear effect, with women showing better performance than men on several different measures in spite of the fact that MacLeod (1991) argued that gender would have only a small influence on performance. Interestingly there were no interactions between sex and age. There were also pronounced age effects, with older participants displaying more Stroop interference than younger participants. Furthermore, they found a significant interaction between age and level of education, which led them to conclude that executive function as indexed by the Stroop task shows marked decline as age increases, and that this decline is increased in those who have a lower level of education. This is consistent with the hypothesis that education gives rise to ‘ reserve capacity’ that protects against the negative effects of the ageing process on cognitive functioning (the ‘ reserve hypothesis’ of brain ageing)

This study aims to replicate these effects with a much smaller participant sample, since large participant groups are unavailable. Van der Elst et al (2006) recruited numerous participants for his study; the lack of numbers will have a predicted effect on the outcome. The participants will be divided into two groups; an older group (over the age of 50) and a younger group (under the age of 25) There are several hypotheses in this investigation.

Firstly, it is predicted that the results will show a Stroop effect. That is, reaction times will be significantly faster on compatible than incompatible trials. h1

Secondly, it is predicted that Van der Elst's et al (2006) findings with regard to gender will be replicated to show that females will show smaller Stroop interference effect than men. h2

Thirdly, it is predicted that the older group will display more Stroop interference than the younger group. h3

Method

Design

The experiment used a mixed design. The Stroop effect was examined using a within-subjects design; participants completed the task in all conditions. The dependent variable was reaction time. However, examination of the effects of age and gender required a between subjects design.

Participants

Forty participants were tested; 10 young males (mean age 19. 8, standard deviation 1. 14), 10 older males (mean age 54. 9, standard deviation 1. 66), 10 young females (mean age 19. 9, standard deviation 1. 26) and 10 older females (mean age 54. 7, standard deviation 1. 49). Participant data supplied from E – Prime, an E – Studio software program based on a visual search experiment by Treisman & Gelade (1980).

Materials

Stimuli were presented using E- Studio software in a quiet computer room. Computers with the same technical specification were used by every participant.

Procedure

Two word lists were developed, one in which the written words and the colour of the words were compatible, and one in which they were incompatible. There were 24 words in each list. Participants were timed reading the colours that the words were printed in for the two lists. Participants were presented with a study that was designed using E Studio software. The participants received instructions to look at a fixation cross that was presented in the centre of the screen in front of them. Next, the stimulus would appear. This consisted of the word ‘ red’, ‘ green’, ‘ yellow’ or ‘ blue’ written in one of the four colours in size 18 Arial font. The stimulus stayed on the screen for up to 2 seconds or until the participant indicated their response using one of four keyboard keys, indicated with stickers of the appropriate colour. The respondents were given 24 practice trials to familiarise them with the key assignment. They were then given a break before the real task, which consisted of 2 blocks of 24 trials each. Compatible and incompatible trials were randomly intermixed. No feedback was given.

Results

The response times for each trial were added together for each participant according to whether the trials had been compatible or incompatible to aid analysis (see Appendix A for raw data). Firstly, a t-test was carried out in order to establish whether this study had shown a Stroop effect. The t-test was significant ($t(39) = -10.917$, $p < 0.001$). Table 1 shows the descriptive statistics for this test.

Table 1 – Mean and standard deviation across participants for the compatible and incompatible trials

	Mean	Standard Deviation
Compatible	12. 785	3. 367
Incompatible	19. 945	4. 711

In order to assess the effects of age and gender on Stoop interference, firstly a Stroop interference quotient was calculated for each individual by subtracting their score on compatible trials from their score on incompatible trials. This was then used as the dependent variable in a between subjects analysis of variance (ANOVA). The main effect of sex was significant (F (1) = 4. 319, p = 0. 45) but the main effect of age group was non-significant and there was no significant interaction effect. Tables 2 and 3 show the descriptive statistics for gender and age group. In order to confirm this result with regard to age, a correlation was carried out between age and the Stroop interference quotient. This was also non-significant.

Table 2 – descriptive statistics for the main effect of gender in the analysis of variance

	Mean	Standard Error
Male	5. 84	. 898
Female	8. 48	. 898

Table 3 – descriptive statistics for the non significant main effect of age group in the analysis of variance

Mean

Standard Error

Younger

6. 59

. 898

Older

7. 73

. 898

Discussion

The first hypothesis was confirmed as the reaction times on the compatible trials were significantly quicker than on the incompatible trials. This is a good result because it lends validity to the rest of our findings. The second hypothesis regarding gender was interesting as there was a significant age of main effect on reaction time. However, the main effect was in the opposite direction predicted and that Van der Elst and his colleagues found the males showed significantly less Stroop interference than the females. It is not entirely clear why males and females would show differential scores on the Stroop task; if taken simply as an index of executive function, it could imply that one group has an advantage over the other as there is less influence of irrelevant yet automatically accessed information on cognition. It is even less clear why this study would show opposite results to those of Van der Elst et al (2006). It is possible that this is due to the linguistic differences between the two studies, although follow up studies would be necessary to examine whether this is indeed the case. It is also possible that the results are due to the differences in sample size between the two studies. However this seems less likely because the result found here was significant, so it should not be a result of chance factors. It could be an artefact of the fact that our study used people who were educated to university level while Van der Elst looked at a wider range of educational attainment. It could also be due to the fact that this study used a fairly small number of trials due to time constraints, although again it would be surprising for this to lead to a significant effect. Perhaps the males were able to learn the key assignments better than the females as men tend to have better spatial skills. This could be tested by using a Stroop task in which participants respond verbally.

The third hypothesis regarding age group and Stroop interference was again not confirmed by the data. However, looking at the descriptive statistics in Table 3 clearly shown that the older group showed over a second more interference on average than the younger group, which suggests that a larger sample may well have come out with a significant result. This is unsurprising as previous studies have shown that the cognitive abilities required for inhibition of the natural response on the Stroop task. The clearest direction for further research is to use a much larger sample in order to gain more comprehensive demographic data and to attempt to confirm the preliminary results found here.