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# Does the Stroop Task Induce Ego Depletion Effect? Brief Experimental Study Among Indonesian Students

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***Abstract****. While there are pervasive canonical examples of the Stroop task effectiveness to induce the ego depletion effect, there were much less is known about how this paradigm used in the Indonesian samples. Our current study aims to investigate whether the Indonesian version of Stroop task would generate ego depletion effect. We hypothesized that increased Stroop task complexity would decrease short-term memory capacity compared to lower difficulty or no task, suggesting an effective ego-depletion effect. Seventy-five university students between the ages of 18 and 21 were randomly assigned into three groups, two depletion and one control conditions. The first and second groups respectively received incongruent and congruent Stroop stimulus through Psytoolkit© online experimental psychology platform, and the third group received no stimulus. We administered the online Corsi block test to participants in the experimental group and compared their scores with the control group to determine whether ego depletion effect, induced by the Stroop task, had occurred. The findings of this online experimental study demonstrate that there were no significant differences (p > .001) in participants' spatial span scores across three groups. The findings of this study suggest that performing the Stroop task to elicit the ego depletion effect should be carried out with caution. Further studies involving more respondents with a higher level of heterogeneity is strongly warranted.*
***Keywords****: Corsi test, Experiment, Ego Depletion, Short-term Memory, Stroop Task, Students*

**Abstrak.** Meskipun ada banyak contoh penelitian yang menunjukan efektivitas tugas Stroop untuk memicu efek *ego-depletion*, masih sedikit yang diketahui tentang bagaimana paradigma ini digunakan dalam sampel Indonesia. Studi ini bertujuan untuk menguji apakah paradigma Stroop versi Indonesia dapat menghasilkan efek *ego-depletion*. Dalam studi ini kami mengajukan hipotesis bahwa tingkat kesulitan tinggi pada tugas *Stroop* akan mempengaruhi kapasitas memori jangka pendek dibandingkan kesulitan rendah dan tampa tugas, dimana hal tersebut menandakan munculnya efek *ego depletion.* Kami merekrut 75 mahasiswa dengan rentang usia 18 dan 21 secara acak yang dibagi ke dalam tiga kelompok dengan jumlah masing-masing 25 partisipan yang terdiri dari dua kondisi eksperimen (*ego-depletion* rendah dan tinggi) dan satu kondisi kontrol. Kelompok pertama dan kedua masing-masing menerima stimulus Stroop yang tidak kongruen dan kongruen melalui aplikasi psikologi eksperimental daring *Psytoolkit*, dan kelompok ketiga tidak

menerima stimulus Stroop. Untuk menguji apakah efek *ego-depletion* muncul, maka kami memberikan tes blok *Corsi online* kepada peserta dalam kelompok eksperimen dan membandingkan skor mereka dengan kelompok kontrol. Hasil studi eksperimental ini menunjukkan bahwa tidak ada perbedaan yang signifikan (p > 0,001) dalam skor rentang spasial peserta di tiga kelompok. Implikasi temuan penelitian ini adalah pentingnya kecermatan dalam menggunakan tugas Stroop sebagai medium pencetus kondisi *Ego depletion.* Penelitian lebih lanjut dengan melibatkan lebih banyak responden dengan tingkat heteregonitas tinggi perlu dipertimbangkan.
**Kata kunci:** *Corsi Test*, Eksperimen, *Ego Depletion, Short-term Memory*, *Stroop Task,* Mahasiswa

Despite the extensive evidence of ego depletion effect in the contemporary behavioral science literature, scholars have been intensively challenged to find the best way to evoke such effects in the experimental research setting. Ego depletion occurs when exercising self-control decreases a person's ability to navigate oneself (Inzlicht et. al., 2019). It is a result of prolonged used of cognitive resources in an activity that expand the use of self-control over a certain period (Oehring, 2020). As an analogy to this effect, human mind works like a muscle, eventually tiring and weakening if it is used for too long without rest (Chaudhuri & Behan, 2004). Baumeister (2002) explained that ego depletion is characterized by decreased concentration, passivity, difficulty to act and think effectively. Individuals who run out of cognitive energy (ego depleted) will find it difficult to control their normative behavior, which disturbing their social and psychological functions.

Scholars warn that ego depletion leads to psychological and physical exhaustion, leading to series of negative reactions, such as behavioral disturbances, aggressions, loss of concentration, and boredom (Dang et al., 2017). Ego Depletion can be caused by several factors, including high personal and social demands, low self-control, large workloads, family problems, and conflict (Chaudhuri & Behan, 2004). In addition, individuals who complete tasks or activities that require cognitive processing, inhibition of impulses, and maintaining focus can also exhibit ego depletion (Hurley, 2019). Scholars suggest that putting individuals in a cognitive task requiring self-control is an effective method to elicit the ego-depletion effects.

Ego depletion effect has been observed in different experiment paradigms, such as reasoning and reading comprehension (Schmeichel et al., 2003), physical exertion (Dorris et al., 2012), taking risks task (Fischer et al., 2012), and false memories test (Otgaar et al., 2012). Recent meta-analytic research has examined how well each depleting task above in producing this effect, however, Dang et al (2021) indicated that the Stroop task has been proven to be among the most effective depleting tasks. Number of studies have suggested that exposing individual to Stroop stimulus is one of the best methods to induce the ego depletion effect (André et al., 2019; Hofmann et al., 2012). The Stroop task is a cognitive test developed in 1935 by John Ridgley Stroop (Macleod, 1991). In its popular version, this test was designed to examine people's cognitive performance by asking them to name the color of the word that appears while disregarding its pronunciation. If the word "red" appears in green, for instance, the correct response is green. This task is frequently used to evaluate cognitive abilities such as attention, memory, and language. Prior study has revealed that attention control is vulnerable to the condition of ego depletion (Dang et al., 2021). To illustrate this, participants in one study were instructed to suppress their feelings while watching an emotionally intense film, or they were allowed to view the film normally. Following that, they were asked to perform the Stroop task, which requires attention control in responding to non-dominant features of a stimulus (font colour) while ignoring dominant aspects (Inzlicht & Gutsell, 2007). Consistent with the idea on excessive self-control would resulting mental tiredness, participants who inhibited their response to the clips performed worse on the subsequent Stroop test compared to those who simply watched the clips.

The premise of what makes a cognitive task successful in eliciting ego-depletion effect is based on the Baumeister et al. (2007) idea that highlighting the degree of effortful control required by the cognitive task to create a significant degree of magnitude of depleting effect. Depletion effect induced by the Stroop task has strongly associated with the self-control hypothesis. This concept explains that people trying to inhibit any impulses using executive cognitive function to achieve certain personal goals (Steimke et al., 2016). In the Stroop paradigm, participants require to attend to a cued target location while in the

same time inhibit the distractions. Scholars believed that this process is highly susceptible to elicit mental exhaustions resulting what it's so called as the ego depletion effect. Completing a self-control task that requires considerable mental effort, and judgements regarding the need for control based on the costs and rewards of reaching task goals are important indicators of good depleting task (André et al., 2019; Shenhav et al., 2017). Based on the above indicators, the Stroop task is considered as an excellent candidate for eliciting high effortful control costs and inducing an ego depletion effect owing to its focused on challenging individual's executive processes (Dang et al., 2021).

While the Stroop's task has been shown to be effective in eliciting ego-depletion in many studies (Dang et al., 2021), recent evidence has questioned whether the ego-depletion effect exists (e.g., Calvillo et al., 2021; Alós-Ferrer et al., 2019), casting doubt on the Stroop task ability to produce the intended effect in different research settings (e.g., Steimke et al., 2016; Osgood, 2017). For example, although a prior meta-analysis by Hagger et al., (2010) suggested that ego depletion negatively affected one's performance on self-control tasks, this impact was shown to be non-significant after one method of controlling for publication bias applied. Another meta-analyses study by Carter et al. (2015) also reported that the ego depletion effect is not significantly different from zero when induced by the Stroop task. Bench & Lench (2019) demonstrate that the Stroop stimulus has potentially to make individuals to feel bored, causing a decrease in reaction time. While Calvillo et al. (2021) discovered little evidence on ego depletion effects from the participants' performances on the Stroop task one week apart in their within-subject study.

In response to the aforementioned findings, we aim to adjudicates this knowledge gap by investigating whether or not the Stroop task can generate ego-depletion effects, leading to variance in participant's cognitive capacity outcomes (spatial-span capacity). We hypothesized that individuals subjected to a higher degree of difficulty in the Stroop task would display decreased short-term memory capacity compared to those exposed to a lower level of difficulty or no task at all, which is suggesting an effective ego-depletion effect.

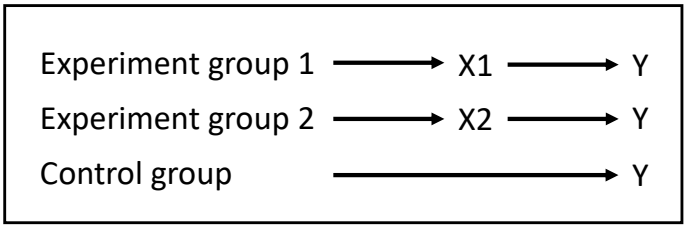
## Methods

### Experiment Design and Participants

This study employed online experimental method using a between group design (see figure 1). We recruited seventy-five university students between the ages of 18 and 21 that were randomly assigned across three groups (n=25), two depletion and one control conditions. All experimental groups have the Stroop task delivered in an online format using Psytoolkit platform (Stoet, 2017). In the first depletion condition (group 1), the participants finished a 100 trials of incongruence Stroop task aiming for high level of ego depletion effect. The second experimental group (group 2) was presented to 100 trials of congruence Stroop stimuli with a medium to low ego depletion expected effect. While the control group was did not exposed to the Stroop task. All groups were measured for short memory capacity, which served as the dependent variable, using the Corsi block test administered in the Psytoolkit program (Stoet, 2017). Scholars suggest that the Corsi block test is among commonly tool to evaluate individual's spatial memory capacity (Arce & McMullen, 2021)

**Figure 1**

*Study design*




### Research Instruments

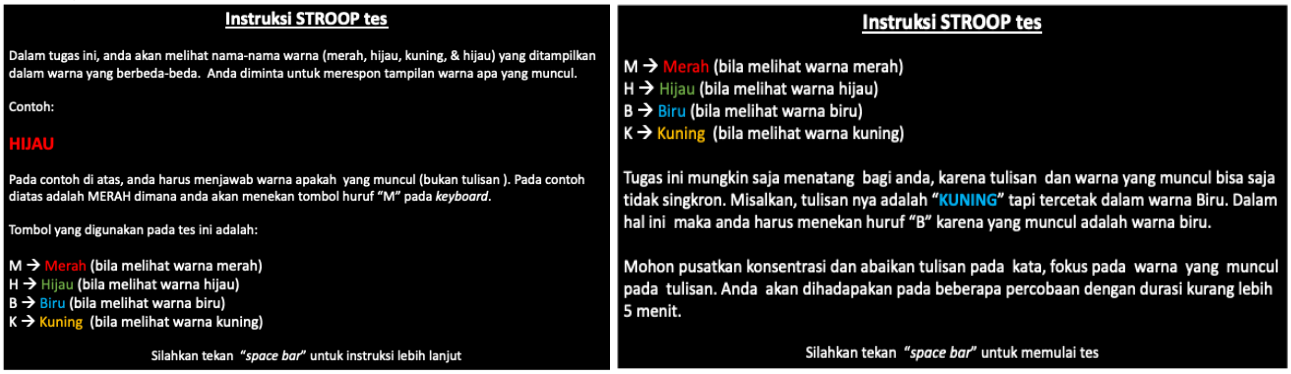
*Stroop Task*

Two versions of Indonesian translated Stroop task stimuli (incongruent and congruent only) were used to manipulate participant's level of ego depletion. The task consisted of four types of stimuli consisting of the words "*mera*h", "*hijau*", "*biru*, and "*kuning*". Each word was displayed on a computer screen in any of these four ink colours.

Please refers to figure 2 and 3 as an Indonesian Stroop task instruction is presented via online platform.

**Figure 2**

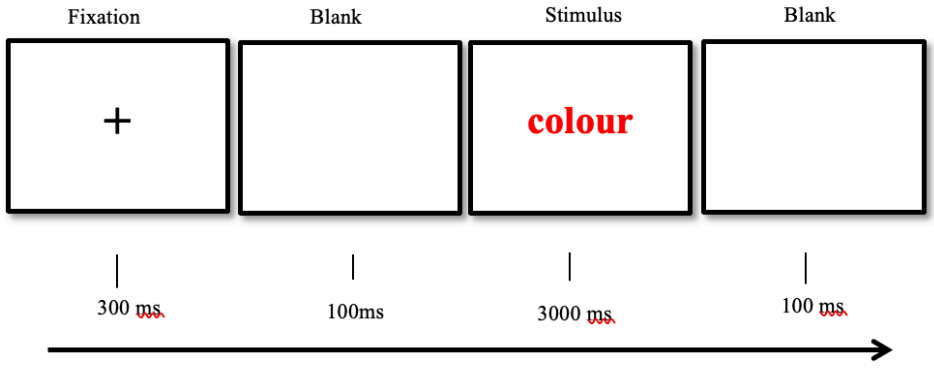
*Stroop task instruction screens*




The two groups (1 & 2) received instructions related to the nature of their stimulus. The first group will undergo 100 trials with incongruent stimuli only. While the second group will also get 100 trials, but it was only focused on congruent stimuli. Congruent stimulus means that the respondent gets the same word and colour stimulus. For example, the word green is printed in green. While the incongruent stimulus means that the respondent gets word with different printed colour, for example, the word green presented in yellow. Respondents could practice the trials to make sure they understood the instructions for each of these tasks. Stimulus performances (congruent & incongruent) are presented randomly in blocks of 100 repetitions in the following order:

**Figure 3**

*Stroop task phases*

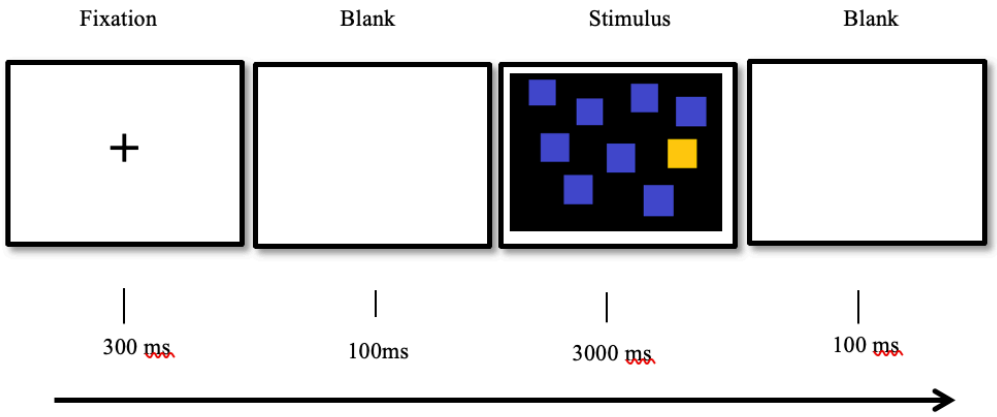


*Corsi Block Test*

The Corsi block test was first used by Philip Corsi in 1972. This test is often used by psychologists to measure individual working memory (Vandierendonck et al., 2004). In this current study, the digital version of the Corsi Block test was used using a psytoolkit (Stoet, 2017). Research participants were showed nine randomly arranged blocks on a computer screen. Then the participant was asked to click the same block in similar order as designated by the system. The sequence of the block is continued with an increasing number of blocks until the participant is no longer able to click the correct block displayed by the system (please refers to fig.4 for details). Participants' scores are based on how many blocks that they were able to tap in the correct order or known as the participant's "spatial span" score (Arce & McMullen, 2021).

**Figure 4**

*Corsi block task phases*




## Results

*Descriptive results*

We recruited 75 participants who were randomly assigned into three groups (two experimental groups and one control group) with 25 participants for each groups. The data were analysed using the JASP open source program (JASP, 2022). The demographic information we had on our respondents indicated that 26 men (35%) and 49 women (65%)

took part in this study. The age of the participants showed that those who were 21 years old (55%) were dominant, followed by those who were 19 years old (23%), 20 years old (17%), and 18 years old (4%).

*Hypothesis test results*

Our assumption test indicated that the data were not normally distributed ($p < .05$), therefore we aimed for the Kruskal Wallis test for a non-parametric test to check our hypothesis. This test used to evaluate if there any significant differences between two or more groups with independent or unrelated samples. A Kruskal-Wallis test results revealed that there was no statistically significant difference in short-term memory capacity test scores between the experimental groups $\chi 2(2) = 0.509$, p = 775 ($p > .05$), with a mean rank of Corsi score of 4.280 for the first experimental group (Group 1), 3.720 for second experimental group (Group 2), and 4.800 for control group (see Table 1).

**Table 1**
*Participants Mean Rank Table*

| | Ego-depletion task groups | N | Mean rank |
|---|---|---|---|
| Corsi's scores | Experiment Group 1 | 25 | 4.280 |
| | Experiment Group 2 | 25 | 3.720 |
| | Control Group 3 | 25 | 4.800 |

**Table 2**
*Kruskal Wallis Result*

| | Chi-square | Significancy | Interpretation |
|---|---|---|---|
| Corsi Test Comparison | 0,775 | 0,05 | Not significant |

## Discussion

This study aims to determine whether the Stroop task can induce ego depletion effects in the Indonesian student samples. Two parameters of the depleting task have been

calibrated aiming for two level of ego-depletion effect; a 100 trials of incongruent stimulus only for high ego depletion effect and a 100 trials of congruent stimulus only for low ego depletion effect. We are expecting the presence of a high level of depletion reaction due to effortful and attention-demanding effect of the incongruent stimulus presented to the experimental group 1. In contrast, in the control group, the participants had simply did not received any ego-depletion manipulation which was not supposed to evoked any depletion effect. Therefore, we believed we had appropriately contrasted the three experimental conditions.

Contrary to expectations, this study did not find a significant difference of spatial span scores between groups. Although this study findings indicated that the control group's scores was actually higher compare to the experimental group 1 and 2, this differences yields no significant results. The findings of this study do not support our hypothesis that there is a significant difference in individual spatial scores between those exposed to Stroop task and no Stroop task at all. Instead, we found that the spatial span score of the first experimental group was even higher than the second experimental groups. In other words, the higher level of ego-depleted participants actually performed better than lower level of ego-depleted participants in the spatial task.

Indeed, this insignificant findings parallel to number of studies that suggesting low to no effect of the Stroop task to ego-depletion effect (e.g., Osgood, 2017; Singh & Goritz, 2018). This appears to contradict previous findings that mentioned such an interference (Dang et al., 2021). Nevertheless, it is may be in line with Carter & Kofler (2015) meta-analysis findings, where although there are differences in participant's cognitive capacity scores, it cannot necessarily be used as evidence that ego depletion is actually occurring and interferes participant's cognitive processes.

Few of explanations for this finding could be; 1) Participant familiarity with the Stroop task diminish its effect. Due to their status as psychology students, the participants' familiarity with the Stroop task resulted in no substantial differences in their scores. As such, it is critical to recruit only individuals with no prior knowledge or experience with the

Stroop task. In light of this findings, it is possible that the Indonesian version of Stroop task is insufficiently challenging to detect ego-depletion effects in highly competent samples.; 2) Boredom while undertaking a Stroop task, especially those in the congruent only stimulus group, may lead to a decline in mental skills. According to previous studies individuals felt more boredom when performing tasks requiring minimal or no modification as opposed to those requiring greater cognitive effort (Bench & Lench, 2019; Mangin et al, 2021). In other words, when individuals struggle to remain mentally engaged in a boring task, their attention shifts to alternate focus, hence diluting their attention from the ongoing activity (Westgate & Wilson, 2018).

Nevertheless, we do not want the readers interpreting this result as suggesting there is no effect of ego-depletion elicited by the Stroop task. Rather, we suggest that these results be used as a consideration in preparing a more thorough and detailed experimental protocol, especially when it is involving psychology student respondents. It is important to remember that this study has a number of limitation that should be taken into account when making recommendations for future research. As it is mentioned above that additional uncontrolled factors, such as boredom and sample characteristics, are probably contributing to no significant findings. In addition, our study was based on limited number of sample size and comes from student samples only. Consequently, there is a need for more number in sample size and variability in the future study. Notwithstanding the relatively limited sample and online experiment method, this study offers some insight into the use of the Indonesian version of Stroop task on eliciting ego-depletion effects. Future studies could explore the possibility of using this task paradigm in a more controlled condition and appropriate number of sample size.

## Conclusion

The objective of this study was to determine whether the Stroop task was effective in evoking ego-depletion effects in the student samples. Based on our findings, there is no significant difference in the cognitive capacity scores between individual who experience

the ego depletion effect and those who do not. There are number of study limitations and implications that could be relevant for future investigation. Hence, this work should contribute to the experimental psychology field's discussion over the use of cognitive tasks to generate ego-depletion effects. The authors believe that this study will lay the groundwork for ongoing studies about the ego-depletion effect in the Indonesian social-cultural context.

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