e-Bangi Faculty of Social Sciences and Humanities Universiti Kebangsaan Malaysia
Journal of Social Sciences and Humanities

eISSN: 1823-884x

Volume 20, Issue 3, DOI: https://doi.org/10.17576/ebangi.2023.2003.12

Article

Comparing Offline and Online Administrations of Measures of Truth Effect, Metacognitive Awareness and Working Memory in Malaysia During The Movement Control Order (MCO)

Chan Wai Mak & Weng-Tink Chooi*

School of Social Sciences, Universiti Sains Malaysia, 11800 Gelugor, Pulau Pinang, Malaysia

*Corresponding Author: wengtink@usm.my

Received: 27 March 2023
Accepted: 17 May 2023

Abstract: This paper described how the truth effect and its relationship with metacognitive awareness and working memory was converted from a physical (offline) administration to an online study due to COVID-19 pandemic-related lockdown measures. The truth effect refers to the tendency for repeated statements to be judged as more true than new statements. Processing fluency is the ease of mentally processing information. The automatic and unreflective mental system associated with processing fluency can be enhanced by repetition. Metacognitive awareness and working memory were conceptualized as a deliberate and analytical cognitive system in the current study. Fifteen offline participants and fifteen online participants were compared on measures of the truth effect, metacognitive awareness, and working memory. There were no significant differences between the offline and online groups in measures of metacognitive awareness, working memory, fluency and the truth effect, suggesting that the online administration of study measures was comparable to traditional methods of administration in a physical laboratory. Even with the small sample size, our findings suggested that statements that were presented more than once were rated significantly more true compared to new information. In conclusion, the truth effect was detected both in online and offline settings in our sample of Malaysian young adults. Our study documented how cognitive tasks can be administered in an online setting using a common teleconference application (i.e., Zoom). Our findings provide support and reference for researchers to conduct research online especially during times of restricted movements and the current climate of working and studying from home.

Keywords: cognitive bias; processing fluency; non-WEIRD population; online experiment; COVID-19

Introduction

Movement restrictions and lockdowns imposed worldwide as an initial and emergency response to the COVID-19 pandemic in 2020 inevitably accelerated a lot of changes in daily lifestyles, such as normalizing working from home and online studying. Many psychological science researchers were forced to adopt changes in their data collection when movement restrictions and lockdowns were prolonged with no end in sight, at the time. This paper described a study that was initially planned for a physical, face-to-face administration in a laboratory setting. The Malaysian government declared a Movement Control Order (MCO) on 18 March 2020 and lasted until 1 November 2021 (Wikipedia, 2021).

The initial lockdown lasted from 18 March to 3 May 2020. The restricted movement was then relaxed from 4 May 2020 till 9 June 2020, dubbed Conditional Movement Control Order (CMCO). This was followed by an even less restrictive control known as the Recovery Movement Control Order (RMCO) which lasted from 10 June 2020 to 31 March 2021. However, the rise in COVID-19 cases led to a nationwide total lockdown from 1 June 2021 to 28 June 2021. On 3 May 2021, the government announced a two-week lockdown due to a sudden rise in COVID-19 cases, followed by a nationwide full lockdown or Full Movement Control Order (FMCO) on 1st June 2021. On 15 June 2021, the Malaysian government enacted the National Recovery Plan which gradually lifted the lockdown. On 1st November 2021, Schools were allowed to reopen in Perak, Penang and Sabah (Wikipedia, 2021).

Participant recruitment for the current study began in December 2020 when the lockdown was less restrictive. Between 16 December 2020 to 6 May 2021, 15 participants completed the laboratory-based experiment. As movement restrictions were reimposed on 3 May 2021, we made the decision to convert data collection to an online platform. Therefore, an internet-based alternative was planned to allow participants to participate from any location, even in the midst of a lockdown.

Brief Background of The Study

The current study investigated the relationship between the truth effect and metacognitive awareness and working memory. The truth effect has been widely studied, showing that when information was seen or heard repeatedly, it had a higher chance of being rated as true (Brashier & Marsh, 2020; Dechêne et al., 2010; Hasher et al., 1977). Hasher, Goldstein and Toppino (1977) discovered the phenomenon when they gave participants the task of rating the truth of ambiguous trivia statements. Participants rated trivia statements consisting of statements seen and rated on the first week. After a two-week interval, participants rated statements consisting of new and repeated statements. The researchers discovered that repeated (old) statements were rated more true compared to new statements (Hasher et al., 1977). Since the seminal study, many studies have since replicated the truth effect (see meta-analysis by Dechêne et al., 2010; De keersmaecker et al., 2019; Brashier, Eliseev & Marsh, 2020)

The truth effect was suggested to rely on processing fluency (Dechêne et al., 2010; Unkelbach et al., 2019), which is the subjective ease when information was processed (Oppenheimer, 2008). Items which were experienced before were processed more fluently, and the perceived fluency could have been used as a cue for truth (Begg et al., 1992). Fluency affects the perception of truth in various ways. When the stimulus was presented was relatively clearer, when it rhymed or was easy to understand, individuals were more likely to believe it (Dechêne et al., 2010; Forster et al., 2013). Fluency was also regarded to be part of system 1 in the dual process theory.

According to the dual process theory, there were two distinct mental systems namely system 1 and system 2 (Stanovich & West, 1997). System 1 was automatic, instinctive, and prone to contextualisation. It possessed the tendency to omit relevant information in favour of quick processing. System 2, on the other hand, was deliberate and analytical which involved decontextualization. Though system 2 was the more rational process, it required more effort. As a result, system 1 was more readily deployed (Kahneman, 2011; Thompson, 2012; West et al., 2008). The dual process model had wide applications ranging from psychology to philosophy (Stanovich, 2011). Unlike system 1, system 2 processed information in a decontextualized manner. This meant that it could construct a mental representation that is de-coupled from prior beliefs, impressions and expectations which better facilitates rational decision-making and thought processes (Mata et al., 2013; Stanovich & West, 2000; Thompson, 2012). Despite system 1 being the dominant thought process, it was possible to trigger the analytical mode of system 2 (Alter et al., 2007; Stanovich & West, 2000).

The violation of mental representation constructed by system 1 was one avenue in which system 2 would be employed. This suggested a possibility that the deliberate control of system 2 could override the bias of system 1 (Evans & Stanovich, 2013; Thompson, 2012). For instance, Swami et al., (2014) found that intuitive thinking, a system 1 process was positively associated with conspiracy thinking. The tendency to engage in conspiracy theory thinking was reduced when analytical thinking was primed using a word fluency task. Alternatively, introducing cognitive disfluency could also elicit analytical thinking. Participants who were exposed to information in a less clear font were more able to detect logical inconsistencies (Alter et al., 2007; Swami et al., 2014). In the current study, working memory and metacognitive awareness served as a component for system 2. Evans (2007) suggested that system 2 required the utilization of working memory which system 1 could do without. Therefore, high working memory could suggest a strong system 2 functioning that might increase the likelihood of a system 1 override.

Alternatively, working memory could also contribute to the truth effect. The repetition-based truth effect was argued to be mediated by memory processes (Dechêne et al., 2010). According to Unkelbach and Rom (2017), the truth effect required that information remain intact in memory. The study also suggested that information encoding was positively correlated with the effect size of the truth effect. As information could be retained longer due to a strong working memory it could inadvertently contribute to the truth effect.

Another factor that could be considered as system 2 is metacognitive awareness. Metacognitive awareness is the ability to be aware of and regulate one's thoughts (Flavell, 1979; Schraw, 1998; Schraw & Dennison, 1994; Vinney et al., 2018; Ward & Butler, 2019). The ability to monitor one's thought process suggests that individuals with high metacognitive awareness could be utilizing a more deliberate way of thinking rather than being reflexive. Metacognitive awareness was suggested to play a major role in reasoning and problem-solving (Quayle & Ball, 2000; Swanson, 1990) and is associated with academic performance in general (Mahadi & Subramaniam, 2013)Studies on metacognitive awareness conducted in Malaysia suggested that it correlated with reading comprehension (Rashid et al., 2006), biology (Veloo et al., 2014) and academic performance in general (Mahadi & Subramaniam, 2013). There is a possibility that metacognitive awareness might enable better focus. Students with high metacognitive awareness were better at selecting moments to text and paying attention at lectures (Rosen et al., 2011). They were also more likely to silent their phone so as to not be interrupted by incoming messages during class (Wijekumar & Meidinger, 2006). Thus, metacognitive awareness might be an important component to overcoming system 1 as deliberate thinkers were metacognitively aware of both intuitive and deliberate thinking (Mata et al., 2013).

The aim of the current study was to determine if online administration of our study variable measures would be comparable to physical administration of these measures in a laboratory setting by comparing results obtained from a laboratory-based setting with those obtained from an online setting. The study also aimed to investigate the truth effect and its relationship with metacognitive awareness, working memory, and processing fluency. Specifically, we aim to determine whether a more deliberate and analytical system, represented by metacognitive awareness and working memory, is associated with the truth effect. Additionally, we seek to explore the relationship of processing fluency in the truth effect, given its automatic and unreflective nature.

Methodology

This section describes research materials and study procedures administered in both the offline and online settings. The inclusion criteria for participant selection were the following: young adults of Malaysian citizens between 20 and 30 years of age, who have an English proficiency level of C or above in the Sijil Pelajaran Malaysia (SPM) or an equivalent qualification.

Fifteen participants (10 women; mean age: 26.7 years) completed the laboratory-based experiment and sixteen (12 women; mean age: 25.1 years) performed the internet-based experiment, with a total of 30 participants who were compensated with MYR 10 for their time. The laboratory-based experiment was conducted in a quiet conference room with a capacity for 6 people in a public university located in the northern region of Malaysia. The internet-based experiment was carried out on ZOOM, a web-based video conferencing tool which allows users to connect remotely for virtual meetings, webinars, and other collaborative activities (Istvan, 1995). ZOOM was selected as the platform for data collection because it allowed the experimenter to share their screen and provided participants with the ability to take control of the experimenter's computer to input and record their responses.

1. Materials

Materials available on https://osf.io/2qvst/ (see ESM_1).

Metacognitive Awareness (MAI and MSAS)

Metacognitive awareness was measured using the Metacognitive Awareness Inventory (MAI) and Metacognitive Self-Awareness Scale (MSAS). The MAI assessed metacognitive awareness with regards to learning (Schraw & Dennison, 1994). The MAI was based on a 5-point scale with the far left being "I never do this" to the far right "I always do this" (Terlecki & McMahon, 2018). The MSAS aimed to assess metacognitive awareness with regards to the self and others (Pedone et al., 2017). Each item was also rated on a 5-point scale. The difference between lab and internet-based experiments was that lab-based was performed on pen and paper while the internet based was performed on google form.

Working Memory (DSB, OSpan and SymSpan)

Working memory was measured using the computerized Digit Span Backward (DSB) and two complex span tasks, namely Operation Span Task (OSpan) and Symmetry Span Task (SymSpan).

In the DSB, a string of digits was presented one at a time with a fixed inter-stimulus interval (ISI). At the end of the sequence, participants recall the digits in the reverse order of presentation. For instance, if the sequence of numbers presented were 6-2-9. At the end of the sequence, participants should recall the digits in reverse order. The correct sequence is 9-2-6.

A complex span task has a storage element and a processing element. The storage element measures how many items the working memory could store. The to-be-remembered (TBR) item could be a sequence of digits, letters, or patterns. The processing element acts as a distractor aimed at giving the working memory cognitive load. The processing element could take the form of determining or verifying the accuracy of an arithmetic operation or determining if the pattern displayed was symmetrical. Operation span (OSpan) task and the symmetry span (SymSpan) task are both complex span tasks. Below describes the administration of the laboratory-based and internet-based administration of working memory.

Laboratory-based working memory tasks

The Digit Span Backward (DSB) task was programmed with the Python language, and participants recalled the digits presented in the reverse order. When the screen prompted them to recall after the presentation of a series of numbers, participants typed in their responses at their own pace.

The Operation Span (OSpan) and Symmetry Span (SymSpan) adopted from Foster and colleagues (2014) were administered through the E-prime software (Schneider et al., 2012). The task would end when participants completed 15 trials or when their accuracy in answering the processing element dropped below 85%. This version also contains a practice trial which allowed participants to familiarize themselves with the task. The practice trial also functioned as a gauge to calculate their average time in completing the processing element (i.e., solving math for OSpan and judging symmetricity for SymSpan). The average time and an addition of a 2.5 Standard deviation were used as a time limit for the processing element (Shelton et al., 2010; Unsworth et al., 2009). Figure 1 presented an example of the OSpan.

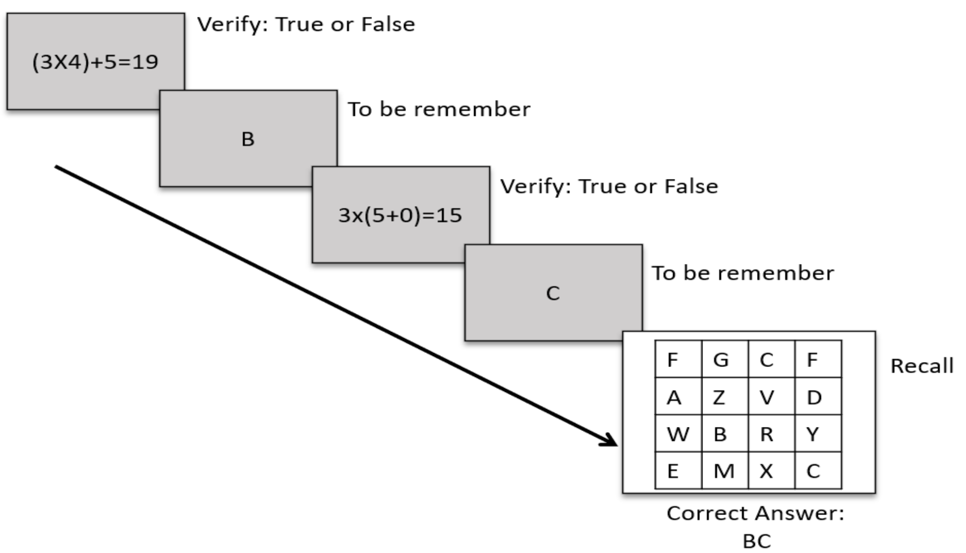

Figure 1. An example of the OSpan, is where the task first begins with the verification of arithmetic followed by a to-be-remembered (TBR) letter. In the recall phase, the letter should be selected according to the sequence presented

The to-be-remembered (TBR) items in the OSpan was a random set of 3 to 6 letters (e.g., D, F, L) for each trial. The trial began with the verification of arithmetic operation, then the presentation of a letter. The verification of arithmetic operations alternated with letter presentation for three to six times, depending on the set size, before the prompt for recall appeared. In the recall phase, participants were to select the letters in the sequence presented. Performance was measured by the number of letters recalled in the correct order (Foster et al., 2014; Lee & Cho, 2019).

The TBR items for the SymSpan were coloured squares on a 4 by 4 matrix. The processing element was to determine if the displayed pattern was symmetrical. The patterns and the presentation of the coloured square were alternated for 3 to 5 times, depending on the set size, before the software prompted the participants to recall the position of the coloured boxes. Figure 2 below is an example of the SymSpan Task.

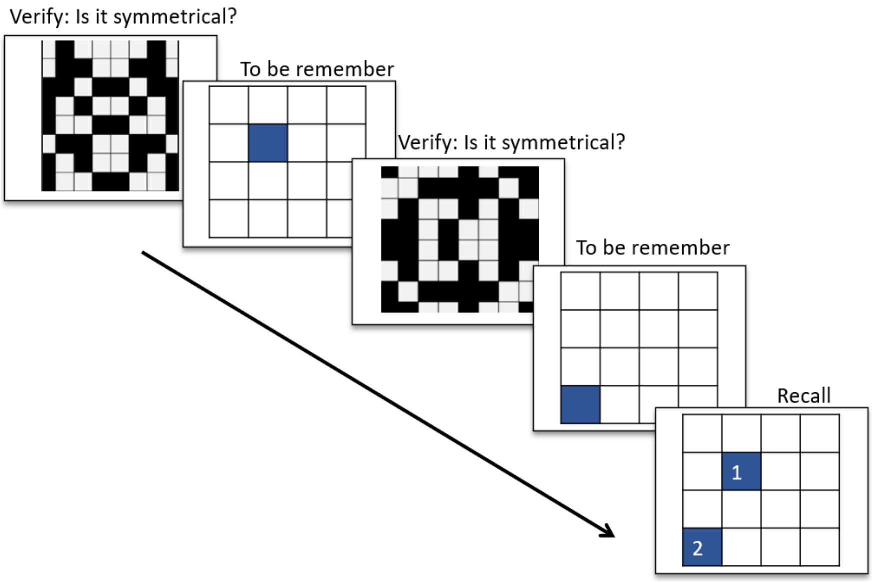

Figure 2. SymSpan consisted of evaluating if patterns were symmetrical and remembering the sequence of patterns (blue square). In the recall phase, participants were to select the location of the square in the order presented

Internet-based working memory tasks

The Internet-based experiment was carried out via the communication platform ZOOM (Istvan, 1995). ZOOM allowed the experimenter to share his screen and allowed participants to control the experimenter's computer. The Digit Span Backward (DSB) was operated on the experimenter's computer, and participants viewed the task through the experimenter's shared screen. Prior to the task, they were told to fold their arm as a safeguard from writing or typing the answers on a separate medium. Participants were also told to only verbalize the answer at the end of each set. The experimenter then typed the digits told by the participants into the DSB program.

The original complex span tasks from Foster and colleagues (2014) were not employed in the online administration because tasks administered on E-prime could not be viewed via the screen sharing function. Thus, complex span tasks from Stone and Towse, (2015) were used instead. OSpan and SymSpan from Stone and Towse (2015) allowed the experimenter to administer the tasks on his computer, share his computer screen and allow participants to control the experimenter's computer to perform the task. In Stone and Towse (2015), both OSpan and SymSpan consisted of 18 trials with no practice trial. The processing element was self-paced. The storage item was not randomized and began with a set of 2 for three trials, after the third trial, the set size increased by one. The trial ended after reaching a maximum of 7. The first three trials of set size 2 were taken as practice. The storage element or TBR item for OSpan, in Foster et al. (2014) was letters, whereas Stone and Towse (2015) used digits (e.g., 3, 53, 62). Whereas for the symmetry span the TBR item was similar for both Stone and Towse (2015) and Foster et al. (2014). It involved remembering a coloured square in a 4x4 matrix.

Statements for measuring the truth effect

The statements utilized consisted of meaningless statements extracted from Unkelbach (2013) (e.g., A Ferrag is broader than a Situ.). Using meaningless statements was intentional for two reasons. One is that familiar trivia statements would trigger repetition within memory which would bias the result. This concern was demonstrated in Unkelbach and Rom (2017). The second reason was that using meaningless statements prevent participants from searching for information on the Web. This is especially so for the internet-based experiment, where experimenters might not know if participants were to verify a given trivia statement using the internet. Participants were shown 45 statements, consisting of 15 True statements, 15 False statements, and 15 neutral statements. The statements were randomized and were shown for 5 seconds each.

Laboratory-based exposure and rating phases for measuring the truth effect

The exposure and rating phases were administered on Psychopy software (Peirce et al., 2019). Before exposing participants to the statements, participants were informed that some statements were True, some statements were False, and others Neutral, devoid of true or false label.

In the Rating Phase, participants were presented with 60 statements with 45 statements without their truth value from the exposure phase. After each statement, participants rated the truth of the statements in response to the question “How likely do you consider the statement to be true?” between 1 – (not at all) to 6 (very likely). After participants rated truth, they rated fluency measured using the 6-item scale proposed by Graf and colleagues (2018) based on five criteria, Effort, Difficulty, Clarity, Fluency, and Comprehensibility:

i. Effort – 1 (effortful) to 6 (effortless),
ii. Difficulty – 1 (difficult) to 6 (easy),
iii. Clarity – 1 (unclear) to 6 (clear),
iv. Fluency – 1 (disfluent) to 6 (fluent)
v. Comprehensibility – 1 (incomprehensible) to 6 (comprehensible).

Internet-based experiment exposure and rating phases for measuring the truth effect

In the online administration, the experimenter ran the exposure phase on the computer. The statements were presented to participants from the experimenter’s screen via the screen-share feature on ZOOM (Istvan, 1995). They were instructed to try to remember as many statements with accompanying truth values as possible.

The rating phase of the task was uploaded to pavlovia.com. This site hosts tasks designed and operated on PsychoPy (Peirce et al., 2019). A link from the site was generated for each task, and the experimenter shared the link with the participants for them to access and complete the task. Participants were told to share their screens before beginning the rating phase, where they rated each statement in response to the question “How likely do you consider the statement to be true?” between 1 – (not at all) to 6 (very likely).

Laboratory-based study procedures

Participants first completed the exposure phase of the truth rating task. They then completed the three working memory tasks – first, the Digit Span Backwards (DSB), then the Operation Span (OSpan) task and the Symmetry Span (SymSpan) task. This was then followed by the rating phase of the truth rating task. All these tasks were completed on the experimenter’s laptop. The experiment ended after participants completed the MAI and MSAS. Participants were then debriefed over the experiment.

Internet-based study procedures

Participants and the experimenter both logged on to the appointed participation schedule on ZOOM. Informed consent was obtained before participation continued with the MAI and MSAS administered on Google forms. After participants completed the questionnaires, they proceeded to the exposure phase of the truth rating task, followed by the three working memory tasks – first, the Digit Span Backwards (DSB), then the Operation Span (OSpan) task and the Symmetry Span (SymSpan) task. They then proceeded to the rating phase of the truth rating task on pavlovia.com. Participants were debriefed after the completing of the rating phase.

2. Data Analysis
A between-subject ANOVA was utilized to compare performance on the working memory tasks, meta-cognitive awareness, and truth ratings between participants from the laboratory-based and internet-based settings. To analyse the truth ratings, repeated false statements were compared to new statements.

The Findings

Descriptive statistics of participants in the study were presented in Table 1. A paired sample t-test was run to compare laboratory-based performance and internet-based performance for metacognitive awareness and working memory. A comparison between metacognitive awareness suggested that Metacognitive Awareness Inventory (MAI) had no significant difference ($t(14)=1.90$, $p=.08$). However, there was a significant difference for the Metacognitive Self-Awareness Scale (MSAS) between the laboratory-based and internet-based ($t(14)=4.56$, $p=-0.0004$). A comparison between working memory tasks suggested that there was no significant difference between the laboratory-based and internet-based performances for all three tasks. There was no significant difference for Digit Span Backwards (DSB) scores ($t(14)=-1.08$, $p=.60$), Operation Span (OSpan) scores; ($t(14)=-.1.15$, $p=.27$), and Symmetry Span (SymSpan) scores ($t(14)=.99$, $p=.34$).

Table 1. Descriptive Statistics of performance for the laboratory-based experiment and internet-based experiment

	laboratory-based		***internet-based***	
Variable	**M**	**SD**	**M**	**SD**
Metacognitive Awareness Inventory (MAI)	198.0	24.68	149.0	23.74
Metacognitive Self-Awareness Scale (MSAS)	70.4	2.13	45.0	2.19
Composite Metacognitive Awareness	268.5	8.04	201.0	7.33
Digit Span Backwards (DSB)	6.1	1.62	6.6	1.30
Operation Span Task (Ospan)	11.9	6.19	14.8	8.32
Symmetry Span Task (SymSpan)	6.9	4.35	5.7	4.35
Composite Working Memory	24.9	8.38	27.1	11.65

M=mean; SD=standard deviation

A composite metacognitive awareness and working memory score was created to have one index of measurement for each variable of interest (Moreau & Wiebels, 2021). In the study, the mean composite metacognitive awareness was M=268.5 (SD=8.04) for laboratory-based and M=201.0 (SD=2.19) and composite working memory was M= 24.9 (SD=8.38) for the laboratory-based and M=27.1 (SD=11.65) for the internet-based.

To compare the truth and fluency ratings between the laboratory-based and internet-based performances, a paired sample t-test was conducted. The measures suggested no significant differences in Truth ratings in both the laboratory-based and internet-based performances, for TRUE statements ($t(28)=1.13$, $p=.71$), FALSE statements ($t(28)=.35$, $p=.68$), NEUTRAL statements ($t(28)=2.05$, $p=.91$), and NEW statements, ($t(28)=-.87$, $p=.56$). Analyses of fluency scores suggested no significant differences between the laboratory-based and internet-based performances for TRUE statements ($t(28)=2.10$, $p=.05$), FALSE statements, ($t(28)=.14$, $p=.19$), NEUTRAL statements ($t(28)=2.31$, $p=.28$) and NEW statements ($t(28)=.76$, $p=.16$).

A repeated-measures ANOVA was conducted to compare truth and fluency ratings between participants for the laboratory-based and internet-based groups respectively. There was a significant effect within the truth ratings, for the laboratory-based truth rating [$F(3,42)=16.32$, $p<0.05$]. Ratings attained from the laboratory-based showed that TRUE statements ($M=3.6$, $SD=0.58$) were rated significantly truer than NEW Statements ($M=2.9$, $SD=0.74$); FALSE statements ($M=3.4$, $SD=0.54$) were rated significantly truer than NEUTRAL statements. NEUTRAL statements ($M=4.0$, $SD=0.64$) were rated significantly truer than FALSE statements. In short, for the laboratory-based truth ratings, there was a significant difference in rating between NEW statements from TRUE and NEUTRAL statements, while FALSE statements were rated significantly differently from NEUTRAL statements. There was also no significant effect between truth ratings amongst participants in the internet-based group [$F(3,42)=0.92$, $p<0.44$]. Likewise, post-hoc Bonferroni comparison showed no significant difference between statements.

There was a significant effect between fluency ratings from laboratory-based participants [$F(3, 42)=28.80$, $p<.05$]. Bonferroni pairwise comparison showed a significant difference between fluency rating for NEW statements ($M=3.9$, $SD=0.80$) and TRUE statements ($M=4.5$, $SD=0.78$). NEW statements were significantly different from FALSE statements ($M=4.3$, $SD=0.73$). There was also a significant difference between NEW statements and NEUTRAL statements ($M=4.6$, $SD=0.85$). NEUTRAL statements were rated significantly different from FALSE and NEW statements. In short, for laboratory-based fluency ratings, NEW statements were rated significantly different from TRUE, FALSE and NEUTRAL statements. NEUTRAL statements were rated significantly different from FALSE and NEUTRAL statements. There was no significant effect between fluency ratings for net $F(3,42)=0.91$, $p=0.44$. Posthoc Bonferroni showed no significant difference between each rating.

Truth and fluency ratings for TRUE, FALSE and NEUTRAL were averaged into a single category as OLD for both laboratory-based and internet-based groups because there was no significant difference between the ratings. OLD Truth ratings for laboratory-based participants ($M=3.7$, $SD=0.47$) and online participants ($M=3.6$, $SD=1.16$) were combined and averaged. Additionally, OLD fluency ratings for laboratory-based participants ($M=4.5$, $SD=0.77$) and online participants ($M=3.7$, $SD=1.23$) were combined and averaged. A bivariate correlation test was run to determine the relationship between variables.

For the laboratory-based group, there was no significant difference between OLD Truth ratings and Composite Metacognitive Awareness ($r=0.32$, $p=0.25$). There was also no significant difference between OLD Fluency ratings and Composite Metacognitive Awareness ($r=0.51$, $p=0.86$). For the internet-based group, there was no significant difference between OLD Truth and Composite Metacognitive Awareness ($r=0.06$, $p=0.84$). There was also no significant difference between OLD Fluency and Composite Metacognitive Awareness ($r=0.17$, $p=0.54$).

For the laboratory-based group, composite WM was found to be significantly correlated with OLD fluency rating ($r=0.69$, $p=0.005$). However, there was no significant correlation between OLD truth rating with either composite working memory ($r=0.5$, $p=0.06$) and OLD fluency rating ($r=0.95$, $p=0.74$). For the internet-based group, all three variables were not significantly associated with another. OLD truth ratings were not significantly correlated with OLD fluency ratings ($r=-0.12$, $p=0.68$) and composite working memory ($r=-0.14$, $p=0.62$). There was also no significant correlation between OLD fluency rating and Composite Working Memory ($r=-0.24$, $p=0.39$). The data for the laboratory-based and internet-based participants are available at: https://osf.io/2qvst/ (see ESM_2).

Discussion

The truth effect is a robust phenomenon, as regardless of conditions, repeated statements were rated either rated truer than non-repeated statements or have a higher likelihood to be rated true compared to non-repeated information. Though statements in the current study were meaningless (e.g., A Wez is older than a Jola), the current finding suggested that the truth effect was equally significant in both laboratory-based and internet-based setting. Neither laboratory-based and internet-based administration of the research materials suggested any significant differences in rating repeated false or true statements. Although the working memory tasks used in laboratory-based and internet-based were different, our findings did not suggest a significant difference in performance between the two groups of participants. The validity of the metacognitive awareness, working memory task, fluency and truth rating were not compromised with no significant difference in performance for participants between laboratory-based and internet-based administration.

For both laboratory-based and internet-based settings, the researcher was visually present for participants to see. In the laboratory-based setting, the researcher was beside the participants, while in the internet-based setting, participants were able to see the researcher through the video calling software. There was a possibility that participants might not act naturally as they felt a sense of being observed by the researcher. Studies have indicated that by merely being aware that there were gazes from photograph, they were less likely to steal (Burnham & Hare, 2007; Nettle et al., 2012).The internet-based setting attempted to be as similar as the laboratory-based setting as much as possible. The researcher was visibly and audibly present, aiding the participants throughout the experiment to minimize misunderstanding.

Participants' scores on metacognitive awareness and working memory tasks were not correlated with how they rate repeated false statements compared to ratings of new statements. This very likely was due to the small sample size reported in this paper. Though metacognitive awareness and working memory were considered a component of system 2 (Oppenheimer, 2008), neither appeared to have influenced the truth effect, a system 1 process, in the current study. Metacognitive awareness did not seem to affect fluency and truth ratings. Participants' ratings regardless of truth value (i.e., TRUE, FALSE, NUETRAL or NEW) in the current study was not significantly associated with scores on the metacognitive awareness scales. In addition to the small sample size, such findings could be due to participants not utilizing their metacognitive awareness when they rated the statements. This is not surprising as utilizing fluency as a rule of thumb was a practical inference of the external world (Herzog & Hertwig, 2013).

Moreover, working memory did not affect how statements were remembered as truth ratings for TRUE statements and FALSE statements were not significantly different, as this suggested that participants did not remember truth values of the statements presented. However, participants seemed to recognize that the statements were repeated, as they rated repeated TRUE, FALSE and NEUTRAL statements differently than NEW statements.

Conclusion

In conclusion, the non-significant differences in all our study variable measures between laboratory-based and internet-based participants suggested that cognitive tasks such as working memory, metacognitive awareness and the truth effect can be conducted online. The findings suggest that the measures were not compromised regardless of the experimental setting (laboratory-based or online). Our findings also suggested that statements that were presented more than once were rated significantly more true compared to new information. However, metacognitive awareness and working memory did not have a significant relationship with the truth effect. These findings indicate that processing fluency was more likely a key factor in predicting the truth effect than deliberate and analytical systems such as metacognitive awareness and working memory.

Moreover, the successful conversion to an online administration reported in this study highlights the potential for researchers to utilize online platforms in their data collection to widen the scope of their research. In the current climate of increased options to work and study from home, having the flexibility to conduct studies online is crucial. Additionally, this is also the first study, as far as we are aware of, that aimed to investigate the truth effect in Malaysia, a non-WEIRD sample. The bulk of the truth effect literature is conducted in Western, Educated, Industrialized, Rich and Democratic (WEIRD) regions in the world. Although we proposed that metacognitive awareness and working memory might reveal individual differences in the occurrence of truth effect, neither appeared relevant to how repeated statements were rated, probably due to the small sample size. We recommend more studies in the psychological sciences to be replicated in non-WEIRD samples and conducted in different settings (e.g., online and in-person), as this will allow for a wider avenue for the replicability of psychological theories and advancing psychological science globally. Nonetheless, the current study contributes to the growing body of research on the truth effect and provides a reference for future psychological science research that would consider data collection methods in an online setting.

Acknowledgement: We would like to thank Universiti Sains Malaysia for providing us with the necessary resources and facilities to carry out this research. We acknowledge the participants who generously gave their time and effort to participate in our study. Their contributions have been crucial to the success of this project. Lastly, we would like to extend our appreciation to our families and friends for their continuous support and encouragement throughout our academic journey. This research was supported by Universiti Sains Malaysia Short-Term Grant (304/PSOSIAL/6315579) to WENG-TINK CHOOI.

Ethical Approval: All procedures in the study were performed in accordance with the ethical standards of Human Research Ethics Committee USM (HREC). Study protocol number [20060303]

Informed Consent Statement: Informed consent was obtained from all participants included in the study.

Conflicts of Interest: The authors declare no conflict of interest.

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