JPPIPA 10(1) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Changing User Behavior in Decisions to Share COVID-19 Misinformation: An Implicit Association Test Study

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Received: July 10, 2023
Revised: October 9, 2023
Accepted: January 25, 2024
Published: January 31, 2024

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DOI: 10.29303/jppipa.v10i1.4616

Abstract: Making medical decisions while distracted when receiving COVID-19 misinformation can majorly impact a person's life and even lead to death. Blatantly sharing COVID-19 misinformation is a significant problem of human behavior that triggers a speed-up and acceleration in the propagation and diffusion of misinformation in social media. While the latest research has focused on understanding the psychological dimensions of this phenomenon, few studies have explored the role of selective exposure and technological prevention when a person considers sharing COVID-19 misinformation, primarily through an Implicit Association Test (IAT). Our study identified and intervened in the association of user exposure between misinformation and implicit truth evaluations by using the Implicit Association Test (IAT) with *"Misinformation vs. Fact Information or Positive vs. Negative Words"*, 38 from 150 participants were either exposed to misinformation headlines or actual new headline posts on stimulants, in the form of images. We then measured participants' implicit truth evaluations and self-reported perceived accuracies of actual and of misinformation headlines using the Visual Selective Attention System (VSAS). After intervening, participants exposed to fake news headlines had lower implicit truth evaluations and increased perceived accuracy. This implies that exposure to fake news headlines after the intervention with the VSAS system may have directly affected implicit evaluations and changed user behavior in sharing COVID-19 misinformation.

Keywords: COVID-19; Implicit association tests; Misinformation sharing; User attention; Visual selective attention system

Introduction

"*Global pandemic puts trust to the test*" is an unprecedented disaster statement released by the (Carroll, 2016). This report annexes a failing trust ecosystem that cannot confront the prevailing COVID-19 infodemic, leaving the four institutions of business, government, NGOs, and media, in a state of uncertainty (Rapoza, 2017). Due of the pandemic, political leaders had to step up their efforts to combat COVID-19, and one such effort was to increase public trust through communication (Kaur et al., 2021). The increasingly vast and growing amount of digital information in today's online media makes us seldom distracted from the actual truth of the information we consume (Osatuyi, 2013; Pennycook et al., 2021). During the COVID-19 pandemic, clear communication about the severity of the situation and the recommended health standards has been vital to ensure that people take the right actions and do not suffer from unnecessary anxiety and mental health issues (Erku et al., 2021). The massive spread of information about COVID-19 hoaxes since 2020 is a problem that any country, including Indonesia, must face (Fardiah et al., 2022).

The presence of a large amount of unclear, ambiguous, and inaccurate information during Covid-19 has contributed to an excess of confusing and contradictory information in the online media which has accelerated health anxiety and Covid-19 misinformation sharing (Laato et al., 2020; World Health Organization,

How to Cite:
Amin, Z., Ali, N. M., Zinaida, R. S., & Helmi, S. (2024). Changing User Behavior in Decisions to Share COVID-19 Misinformation: An Implicit Association Test Study. *Jurnal Penelitian Pendidikan IPA*, *10*(1), 63–71. https://doi.org/10.29303/jppipa.v10i1.4616

2021) Experts argue that reliance on misinformation related to Covid-19 fuels negligence in prevention and a reluctance to take protective measures, which in turn leads to an increase in the threat of serious illness or even death (Barua et al., 2020). Along with health repercussions, the Covid-19 pandemic will have a number of secondary effects that must be dealt with, including economic, social, and political ones (Muqsith et al., 2021). Since 2019, during the Covid-19 Pandemic, it is necessary to apply appropriate communication strategies (Isnawijayani et al., 2022) Because people often tend to expose themselves to affirmative information and selectively share Covid-19 information based on their attitudes and beliefs (Pennycook et al., 2018), a fundamental prevention of the spread of the infodemic is one way to reduce the ongoing exposure to misinformation which corrupts one's knowledge and beliefs (Kümpel et al., 2015; Vicol, 2020).

A clear understanding of the different cognitive processes in each user that underlie the formation and activation of implicit and explicit evaluations through the Implicit Association Test (IAT) could help to explain how fake news about COVID-19 affects people's judgments and beliefs (Mosseri, 2016). Based on this, we conducted a study intended to expand the work of , which measures implicit associations on user behavior, particularly in decisions to share misinformation about COVID-19 (Chen et al., 2012; Zizlsperger et al., 2012). Although research into many aspects of COVID-19 has begun among social scientists (Bonchi et al., 2011) our research focuses on significant psychosocial effects of the virus, such as evaluating information received through a technological intervention based on the Human-Computer Interaction (HCI) field core domains (Ab Rahman et al., 2017; Bakshy et al., 2009; Niemantsverdriet et al., 2019). The time has come to focus interdisciplinary research that addresses the psycho-social-behavioral and technical prevention aspects of COVID-19 misinformation spread, building on prevention recommendations and other initiatives.

In this study, we aim to identify the role of epistemic belief factors associating with user behavior in sharing COVID-19 misinformation and intervene into user behavior as they are evaluating misinformation for potential sharing COVID-19 using Implicit Association Test (IAT) in pre-and post-intervention experiments using the Visual Selective Attention System (VSAS) system (Chelazzi et al., 2013; Hodas et al., 2012; Lee et al., 2013; Posner et al., 2018; Rensink, 2002). This paper is divided into six sections. Section 1 contains an introduction. Section 2 defines COVID-19 misinformation theory, the IAT and discusses related research. Section 3 discusses methods used to clarify the constructs of the study proposed. Section 4 analyses the results of the IATs and experiment sessions, followed by Section 5 which is a discussion. Finally, Section 6 concludes the study and provides pointers to future directions.

According to Munar et al. (2014), Guo et al. (2020), Zinaida et al. (2019) the authors suggest that social media application designers should look at attentional factors and other psychological factors that influence users' decisions to share Covid-19 misinformation as a dynamic and fundamental process when they are designing attention management views (Amin et al., 2021; Ghaisani et al., 2017; McAvinue et al., 2012; Weng et al., 2012) particularly regarding the behavioral handling of sharing information on COVID-19. This is in line with the need to understand the significant limitations in human behavior when receiving online information: the lack of visual cognitive abilities and the ability to pay greater attention in a short time during which the associations of beliefs hold influence (Yang et al., 2014) . In addition, a recent study during COVID-19 misinformation found an increased intention to share unverified information (Laato et al., 2020; Wu et al., 2019) and a large amount of unstructured information that could increase the spread of fake news (Ndinojuo, 2020).

Previous studies have identified various intrinsic predictors for sharing fake news, such as lack of verification skills, information abundance, and online trust (Khan et al., 2019; Talwar et al., 2019). Moreover, users are also strongly influenced by confirmation bias (Garrett & Weeks, 2017), which means they are more likely to believe information when it aligns with their own pre-existing views or opinions regardless of whether the information is accurate or not (Kim et al., 2019; Vicario et al., 2019). First revealed by Greenwald et al. (1998) the Implicit Association Test (IAT) is an experimental standard designed to measure the extent to which individuals align two dichotomies. This early use of the IAT focused on identifying tendencies in the valence of issues and attitudes toward different groups in the context of belief associations to race (Chua et al., 2017). An example of this is the leaning to associate between "*Black faces with negative concepts*" and "*White faces with positive concepts*".

The Implicit Association Test (IAT) is a computer-based test that assesses rapid reaction to a block of stimuli presented to participants on a screen. IAT is a method to indirectly measure the strength of associations between concepts (Nosek, 2007). In the context of the present study, we attempted to measure implicit attitudes by measuring the automated evaluation that users underlie when sharing information about COVID-19. To compare changes in user behavior, we also divide this test into two parts, pre- and post-

intervention, where the intervention was the use of the Visual Selective Attention System (VSAS) tools. The technique for calculating scores on the IAT is to use the primary data source, particularly the response time, which is called the latency score. Greenwald et al. (2003) developed the scoring algorithm was used to compile reaction times and standard scores called D-scores, generated for each participant. The D-Score is similar to Cohen's d effect size and can range from -2.00 to 2.00.

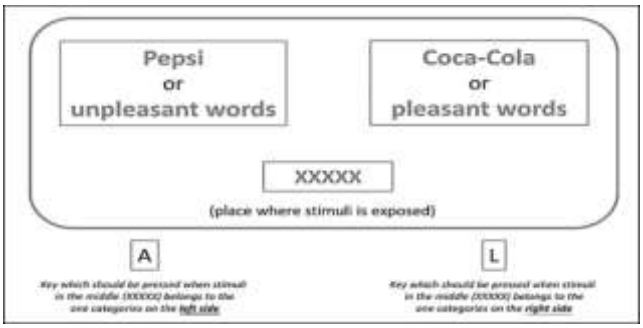

Figure 1. An example of application of the IAT task into consumer studies (Maison et al., 2001)

The research is particularly relevant in the context of the COVID-19 pandemic, where information missions can have serious consequences both in terms of public health behavior and in trust in authority and science. In addition, understanding can help in developing effective communication and education strategies to address health-related misinformation in the community.

Method

In our Implicit Association Test, we use a computer-based test on Pavlovia and PsychoPy platform to stimulate participants on a screen and this can be accessed via the Pavlovia website at *https://run.pavlovia.org* (see Figure 2). Of the entire 150 participants (from Study 1), 38 were expressly recruited for the IAT experiment. With an average age of 20 (SD = 1.11) and all being students, there were 38 participants in total 27 men and 11 women. For their participation, participants received $5. Additionally, a full IAT takes about 15 minutes to complete. Each VSAS experiment took 1.5 to 2 hours to complete.

The whole IAT task involves five blocks of tasks (see Figure 3), and the response keys 'A' and 'L' are assigned for specific categories. If the participants give the wrong response, an error sign will appear *("oopss"* notification), and if they give the right response, a plus (+) sign will appear. Blocks 1 and 2 are practice trials, where participants are asked to accurately sort words in the first block and images in the second block. Block 3 is a combined task of both blocks with the same response keys assigned to each category as before. Block 4 is almost equivalent to block 3, except that the key assignments for both categories are reversed. Block 5 is a repetition of blocks 1, 2 and 3 with the exception of the response keys which are reversed (see Table. 1).

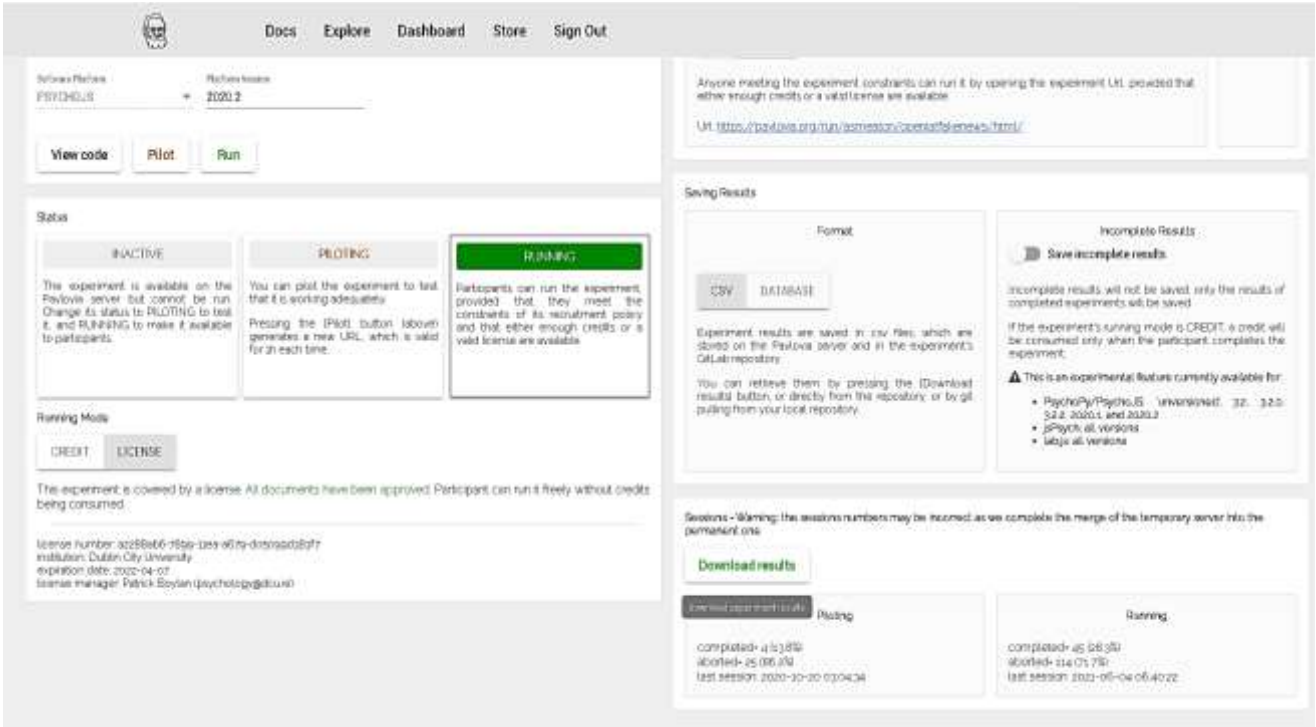

Figure 2. PsychoPy dashboard page in Pavlovia

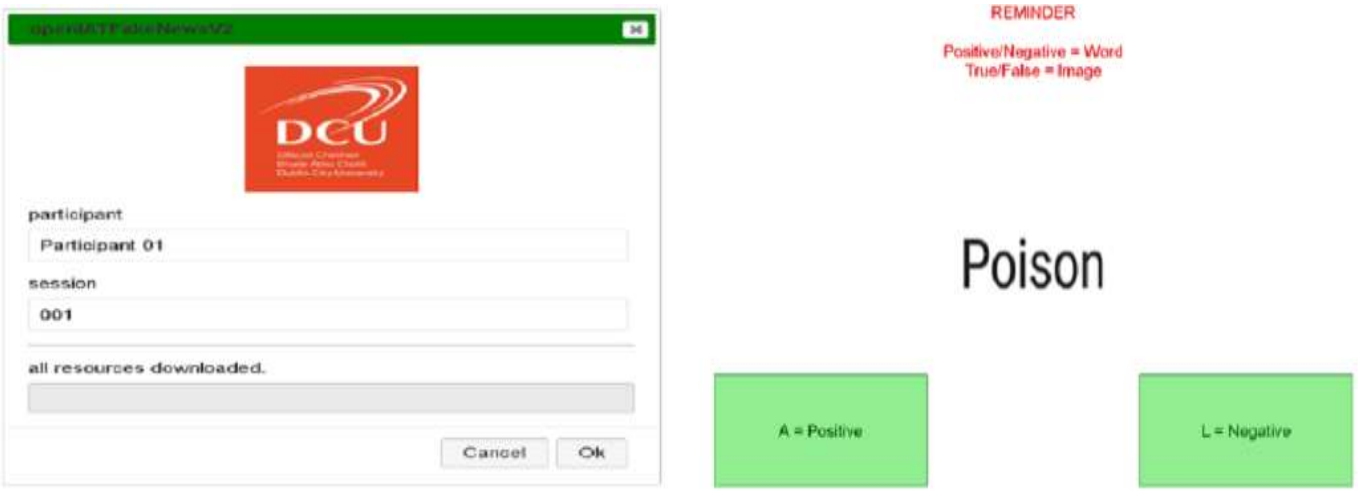

Figure 3. The whole IAT task involves blocks of tasks in pavlovia

Table 1. Sequence of Trial Blocks in Misinformation vs Fact Information or Positive vs Negative Words IAT

Block	No. of trials	Function	Category	Item assigned to left-key (A) response	Item assigned to right-key (L) response
1	10	Practice	Positive and negative word	Positive word	Negative word
2	10	Practice	True and false image	True image	False image
3	22	Test	True or positive (combined with image and word) and false or negative (combined with image and word)	True or positive (combined with image and word)	False or Negative (combined with image and word)
4	10	Practice	False and true image	False image	True image
5	22	Test	False or positive (combined with image and word) and true or negative combined with image and word)	False or Negative (combined with image and word)	True or positive (combined with image and word)

Table 2. IAT Results Meaning Adopted From (Greenwald et al., 2003)

IAT Results	Meaning
-2 to -0.65	Strong Negative Association with evaluating "Misinformation vs Fact Information or Positive vs Negative Words"
-0.65 to -0.36	Moderate Negative Association with evaluating "Misinformation vs Fact Information or Positive vs Negative Words"
-0.35 to -0.15	Slight Negative Association with evaluating "Misinformation vs Fact Information or Positive vs Negative Words"
-0.15 to 0.15	Neutral/ No Preference
0.15 to 0.36	Slight Positive Association with evaluating "Misinformation vs Fact Information or Positive vs Negative Words"
0.36 to 0.65	Moderate Positive Association with evaluating "Misinformation vs Fact Information or Positive vs Negative Words"
0.65 to 2	Strong Positive Association with evaluating "Misinformation vs Fact Information or Positive vs Negative Words"

The experimental process was carried out in two sessions with pre and post-intervention. In the pre-intervention (in the first week), 38 participants were sent ten contexts of information using before VSAS (in this session, the VSAS feature was limited, so no intervention was carried out), but still aimed to collect response data and identify participants' decisions when receiving and sharing information. Next, 38 participants continued to the IAT session, where this session was to establish a baseline (initial condition) that described the association's tendency in 38 participants. In the post-intervention (in the second week), 38 participants repeated the VSAS session, but the intervention features were used as a whole in this session. Furthermore, participants continued to the second IAT session to see changes in participants' decisions in evaluating the information provided. The results of the second IAT session became a reference for measuring the success of the pre and post-intervention processes that had been carried out.

Result and Discussion

After participants completed their use of the VSAS tool and we finished analyzing the results of the experiment to assess its impact on their sharing of

misinformation, we analyzed the IAT scores of 38 participants. In this second user session where we performed IATs, only 23 participants completed the test, and 15 others did not participate for various reasons, mostly to do with their availability. From among the 23 participants, we found a meaningful increase in their ability to evaluate the IATs. There are significant results on how they could increase their evaluation and attention to the association between *"Misinformation vs Fact Information or Positive vs Negative Words."* IAT results show that there are still relatively many score participants in the D-score positive area. The D-Score is similar to the Cohen's d effect size and can range from -2.00 to 2.00. The IAT scoring algorithm in which D-Scores above zero indicate a positive association, and D-Scores below zero indicated a negative association. In other words, a positive D-Score would indicate quicker associations between *"Misinformation vs Fact Information or Positive vs Negative Words"* (Greenwald et al. 1998). The IAT scores for the 23 participants in session 1, shows that there are still relatively many participants who tend to be incorrect in evaluating which information (stimulated by images) are true facts and which are misinformation, including (vs.) which words are in the positive and negative categories.

The set of IAT scores also show a very balanced distribution among our participants with 11 below 0 and 12 above 0. After the participants used intervention with the VSAS system, the tendency of user associations in evaluating improved where only 4 of 23 participants still show a positive IAT score. In the context of this study, D = negative indicates that D-Scores below zero indicated a negative association, where users do not tend to have associations (when they are confronted with congruent and incongruent blocks) to evaluate which information is fact and which is misinformation. Based on these results, we can state that use of the VSAS system is validly able to improve user evaluation in the context of measuring *"Misinformation vs Fact Information or Positive vs Negative Words."*

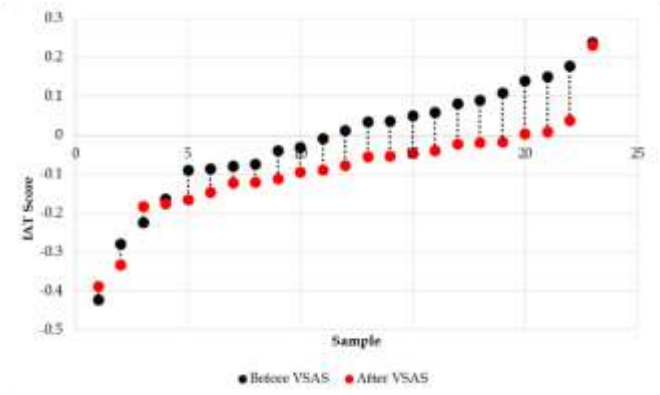

Figure 4. IAT scores for participants before and after their VSAS experiment

Finally, to clearly determine the success of the response on user behavior changes and overall user evaluation via IATs through pre-and post-intervention using VSAS, Figure 4 shows the pre- and post-intervention IAT scores for each participant where as many as 19 of 23 participants experienced significant changes. Each pair of dots in Figure 4 shows the D-score distance before (black dot for before VSAS) and after (red dot for after VSAS). The distribution frequency of these changes includes 17 users in the "*Neutral/No Preference*" D-Score category, 4 users in the "*Slight negative*" D-Score category, 1 user in the "*Moderate negative*" D-Score category, and 1 user in the "Slight positive" D-Score category (see Table 3 and Table 4).

Table 3. Distribution of Implicit Scores before VSAS Experiment

D-Score	Category	n	Percent
-2 to -0.65	Strong negative	0	0.0
-0.65 to -0.36	Moderate negative	1	2.6
-0.35 to -0.15	Slight negative	3	7.9
-0.15 to 0.15	Neutral/ No Preference	16	42.1
0.15 to 0.36	Slight positive	3	7.9
0.36 to 0.65	Moderate positive	0	0.0
0.65 to 2	Strong positive	0	0.0
	Missing	15	39.5
	Total	38	100.0

Table 4. Distribution of Implicit Scores after VSAS Experiment

D-Score	Category	n	Percent
-2 to -0.65	Strong negative	0	0.0
-0.65 to -0.36	Moderate negative	1	2.6
-0.35 to -0.15	Slight negative	4	10.5
-0.15 to 0.15	Neutral/ No Preference	17	44.7
0.15 to 0.36	Slight positive	1	2.6
0.36 to 0.65	Moderate positive	0	0.0
0.65 to 2	Strong positive	0	0.0
	Missing	15	39.5
	Total	38	100.0

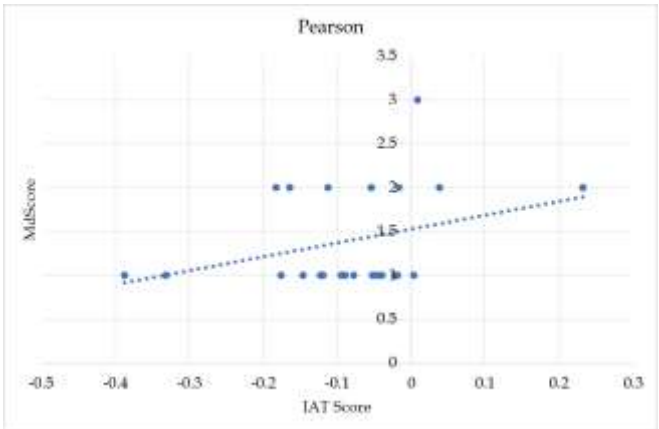

Figure 5. Pearson correlation on IAT Score (after VSAS) and MdnScore on sharing misinformation

In the last IAT analysis step, we calculated the correlation between the IAT Score and the MdnScore (Median Score). We then also calculated the percentage weights for each question's score, calculated the variance, and the ranking. The correlation between IAT Score andMdnScore(Median) in sharing misinformation showed a significant moderate positive correlation of p = +0.3344 (Garson, 2012) (see Figure 5).

In Figure 5, the 95% confidence interval (CI) shows a significant result where two 95% CI error bars "*less overlap*" for the IAT Score in session one and session two and the number of samples is the same, and the P-value is less than 0.05 (Payton et al., 2003). This result also shows a significant positive relationship between IAT score session 1 and IAT score session 2, r(23)=.95,p=.000.

Table 5. Pearson Correlation between IAT Score Session 1 and Session 2

		IAT Session1	IAT Session2
IATSession1	Pearson Correlation	1	.959**
	Sig. (2-tailed)		.000
	N	23	23
IATSession2	Pearson Correlation	.959**	1
	Sig. (2-tailed)	.000	
	N	23	23

***. Correlation is significant at the 0.01 level (2-tailed).*

Based on the research reported here, we show that an intervention using the VSAS tool has succeeded in changing user decisions about sharing COVID-19 misinformation. This is evidenced by the success of the user in evaluating "*Misinformation vs. Fact Information or Positive vs. Negative Words*" in the post-VSAS intervention IAT session concluded that a lack of critical thinking can be related to a user's lack of accuracy and attention in consuming fake news, which involves an automated process in the context of one's beliefs.

In the IAT study reported here, we exposed participants to fake news headlines about COVID-19, who had previously used the VSAS system which raises awareness about sharing miss-information. After the intervention experiment was completed, a second IAT session was completed to evaluate participants' views on the truth related to implicit and self-report accuracy of information presented to them for possible sharing. There are several limitations to the design of this study, including the se of 15 participants lost due to them not being able to complete the full set of tests. Future study designs should look towards developing IATs with a larger sample size to account for potential loss of data accuracy.

The categories of participants who completed our pre- and post-experimental IATs and used VSAS had an average age range of 20 years to 35 years. This shows the limitations of the results of the participants' behavior response data in applying VSAS on IATs. For this reason, it is necessary to increase the number of participants in the middle and older age categories. Another demographic issue is the participants' origins, cultures, and legal regulations, which indirectly affect user decisions in sharing information where the origin of the participants in this study is only from Malaysia or from Indonesia. For this reason, in future research, it is necessary to increase the number participants from the "*multicultural*" aspect in order to get more data and knowledge, especially regarding user evaluation when deciding to share COVID-19 information on social media.

Conclusion

Based on such ethical and philosophical concerns, we try to interpret the concrete implications of our research as a contribution to the body of knowledge on sharing of misinformation, and also to analyse the value of alternative technology solutions, particularly in the area of Human-Computer Interaction (HCI). The next stage of our work will address changing user behavior via an improved intervention technique when users do decide to share information about COVID-19. Inevitably we realize that the next question will be about who has the right to assess that the fact-checker source itself is constantly credible, whether it might be a government or an appointed consortium. In future work, we encourage transparency across social media platforms through collaborating with scientists and researchers directly. The results of the study reported here clearly show that participants who use the VSAS system can change their behavior in deciding whether or not to share information, and this is supported by the results of our IAT tests. This assertion also confirms that the VSAS application and the representation of a significant relationship shown by IAT evaluation can successfully trigger the targets for "*behavior change.*"

Author Contributions
The role of the author in this study is the executor of this research.

Funding
This research received no external funding.

Conflicts of Interests
We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organization related to the material discussed in the manuscript.

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