

# An Experimental Study on Tracking Identity of Moving Shapes: Do Stimulus Complexity and Familiarity Affects Tracking Accuracy of Male and Female Students?

## Shuyang Zhang (1)

Universiti Putra Malaysia, Malaysia  
chzuzsy2018@sina.com

## Hashvini B.Kaliselvan (2)

Universiti Putra Malaysia, Malaysia  
hashvini@hotmail.com

## Tong Zhang (3)

Universiti Putra Malaysia, Malaysia  
z747535997@sina.com

## Aini Marina Ma'rof (4)

University Putra Malaysia, Malaysia  
ainimarina@upm.edu.my

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Corresponding

Author:

Aini Marina Ma'rof &  
ainimarina@upm.edu.my

### ABSTRACT

*The current study explored effects of stimulus complexity and familiarity on tracking accuracy between male and female postgraduate students in Malaysia. Since online courses are not restricted by location, the convenience of recording classes has become a steady trend especially during the COVID-19 period. However, some are also skeptical about the efficacy of online teaching and learning through the digital environment and believe that the stimulus generated on these foundations will result in undesirable consequences (Dhawan, 2020). As student attention determines their tracking accuracy, external factors like stimulus complexity and familiarity tend to be an obstacle for students to be attentive. In this quantitative experimental study named "Simon Effect", 24 postgraduate students (12 males and 12 females) in a Malaysian public research university were used as samples to test whether or not gender plays a role in tracking accuracy. Results show that gender does not influence tracking accuracy of the postgraduate students. At the same time, the stimulus complexity and familiarity do influence tracking accuracy of the postgraduate students. The implication of the study lies in*

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*promoting the teaching and learning sessions not only for a postgraduate student but for all the students in different educational levels during the COVID-19 period and maximizing the educational outcomes.*

*Keywords: Online courses, eye-tracking, attention, teaching and learning, COVID-19*

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## **INTRODUCTION**

Nowadays students are often sitting in front of the screen of the computer instead of the classroom to the classes and they are required to focus on the lesson while sitting in the home which causes them a distraction, especially during the COVID-19. Even COVID-19 continues but teaching and learning do not stop. Online courses are not restricted by location and the convenience of recording the classes has become a blowout development trend. As Benbunan-Fich and Hiltz (2003) have highlighted, online courses maximize time and effort for both students and teachers. For instance, going to school or home time, transportation or driving time, finding classroom time in the new semester, etc. In the last five years, research in Robert Morris University has examined students who have a good opinion of online courses, which they consider to be "efficient and convenient". In other words, online courses save time and are freer (Cole, Shelley, & Swartz,2014). On the contrary, some individuals are also "skeptical" about online teaching and learning through computers (Zhang, 2021), and believe that the stimulus generated on these foundations will bring a slice of undesirable consequences (Dhawan, 2020), like the length of the word, the frequency of the same short familiar words which is different from the traditional class on the basis, the learning efficiency and learning results are also different.

Visual stimuli and familiarity affect tracking accuracy (Hyona, Oksama, & Rantanen, 2020) in students' online courses. Besides, students who are participating in classes from home might be disturbed by family members, pets, or other issues that affect their concentration and give a problem to their tracking accuracy (learning)(Roe, Blikstad-Balas, & Dalland, 2021). As William James argued, attention is effectively withdrawing from some things to deal with others (Goldstein, 2019). Furthermore, gender is also considered one of the many factors that influence

the appearance of track accuracy, as studies at both the genetic and physiological levels have shown that differences in gender influence track accuracy.

### ***Stimulus complexity, familiarity, and tracking accuracy***

For a long time, tracking accuracy has been paid attention to and studied by the public because of its advantages and disadvantages. Tracking accuracy also exists in a slice of fields. Like aerospace flight, air traffic control, P.E sports, non-native language learning, and a slice of other fields. In other words, tracking accuracy is closely related to people's study, life, work, etc. exploring the reasons that affect tracking accuracy is of great practical significance; grasping the law of tracking accuracy can make our study, life, and work better.

To retain situation awareness of our visual surroundings so that we can engage with it or respond appropriately to moving things, we must keep track identity of the objects, knowing what each item is and where it goes to (Li, Oksama, & Hyona, 2019). That is called tracking accuracy. Tracking accuracy is also related to our foveal vision. When the foveal attention is directed on one target for processing the object's identity information and renewing the binding between the object identity and its present location, the tracking accuracy of the object is also increased (Huang, Veeraraghavan, & Sabharwal, 2020). The foveal attention alternates between target objects serially to keep each object's identity-location binding up to current. At any one time, only the presently attended item is properly monitored (Stewart, Valsecchi, & Schutz, 2020).

On the other hand, stimulus complexity is the stimulus parameter that reflects a stimulus's complexity. For instance, a stimulus pattern might be complicated. The more complicated the stimulus, such as a song, the more information processing capability is required to analyse it, and the reaction time will be greater (Global, 2022). The differences in the complexity of a stimulus can vary the perceptual response of a person. For instance, perceptual learning specificity is connected to the visual cortex's hierarchical organisation: low-level cortical regions demonstrate remarkable specificity for low-level stimulus properties (low stimulus complexity) such as orientation and spatial location. Higher-level structures (high stimulus complexity), on the other hand, are frequently selective for sensory qualities like as

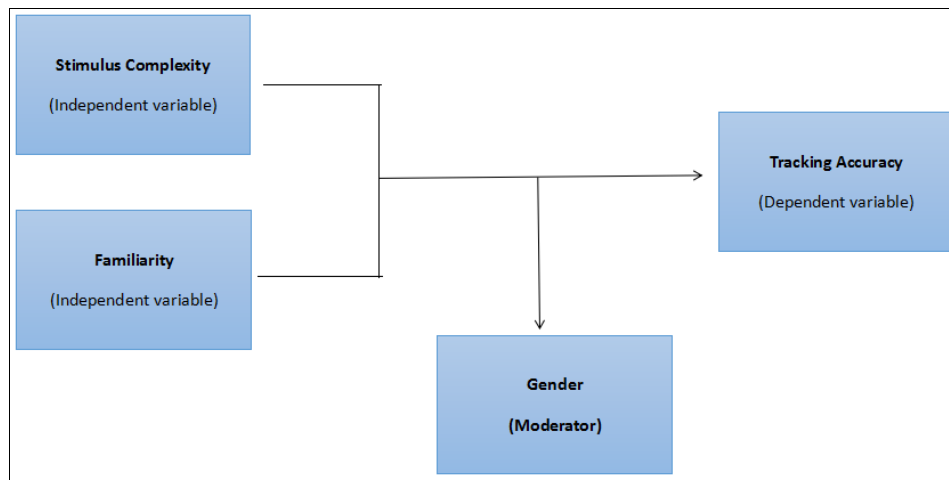
form or motion, with little reliance on the stimulus's particular composition or spatial location (Doshier, Jeter, Liu, & Lu, 2013). Thus, the issue of diminishing perceptual learning's spatial specificity may be expressed in terms of boosting the contributions of neurons in higher-level cortical regions to the perceptual response.

Based on the above, it is not difficult to find the important role of tracking accuracy. In fact, researching the relationship between tracking accuracy and learning has strong theoretical and practical significance, especially when the COVID-19 epidemic has entered the "global white-hot" stage, affecting the teaching and learning process of teachers and students the world. Hyönä, Oksama and Rantanen (2020) noted that the stimulus complexity affected tracking and long words are harder to track than short words. Furthermore, Ponce, Mayer, Sitthiworachart and López (2020) argued that the effects on response time and accuracy of technology-enhanced cloze tests. Computer-assisted exams should make use of affordances that make it easier for examinees to indicate their response. As McQuirter (2020) mentioned that online courses expose participants (students and teachers) in educational practice to the latest challenges. Previous studies of the effects of Shadowing and Tracking on Intermediate EFL learners' oral fluency and visual attention in kinematics had emphasized potential problems and solutions. Yavari and Shafiee (2019) showed that the positive combined impact of shadowing and tracking on speaking fluency of EFL learners. Klein et al. (2020) also found that students' eye movements (tracking accuracy) correlate with learning confidence and performance feedback. In other words, eye-tracking can make unique contributions to validating concept inventories. These studies provide a slice of necessary theoretical and practical support for exploring the relationship between tracking accuracy and the complexity and familiarity of stimuli.

### ***Conceptual / theoretical framework and hypotheses development***

This study's conceptual and theoretical framework is presented below (Figure 1). Two variables including the stimulus complexity, the stimulus familiarity is introduced to explore the relationship between gender, and the gender which could further be a mediator for influencing tracking accuracy. The indirect effect of the stimulus complexity and familiarity on tracking accuracy could be mediated by gender or have no relationship.

**Figure 1.** Conceptual Framework of The Relationship Between Stimulus Complexity, Familiarity, And Tracking Accuracy



However, the prior studies above are simply based on individual categories which affects the tracking accuracy and sample are from different countries and have never been carried out in Malaysian Postgraduate students. When the tracking accuracy factors are tested individually, although the results were positive, it will be difficult to compare with the same sample under the same population. So this current study is more to compare the factors include the stimulus complexity, and familiarity that affect the tracking accuracy of postgraduate students, the following three questions are of considerable interest to us: (1) Does gender influence the tracking accuracy of postgraduate students in UPM? (2) What is the relationship between stimulus complexity and track accuracy of postgraduate students in UPM? (3) What is the relationship between familiarity and track accuracy of postgraduate students in UPM?

It is expected that the greater the complexity of the stimulus, the lower the tracking accuracy, the higher the sample's familiarity with the stimulus, the higher the tracking accuracy, and the shorter the eye-tracking time of the sample. Based on the review of the stimulus complexity, familiarity, and tracking accuracy as well as a slice of other related experimental studies, we put forward the three hypotheses below:

**H1:** There is a significant difference between tracking accuracy of male and female postgraduate students in University Putra Malaysia (UPM).

**H2:** There is a significant relationship between stimulus complexity and track accuracy of postgraduate students in University Putra Malaysia (UPM).

**H3:** There is a significant relationship between familiarity and track accuracy of postgraduate students in University Putra Malaysia (UPM).

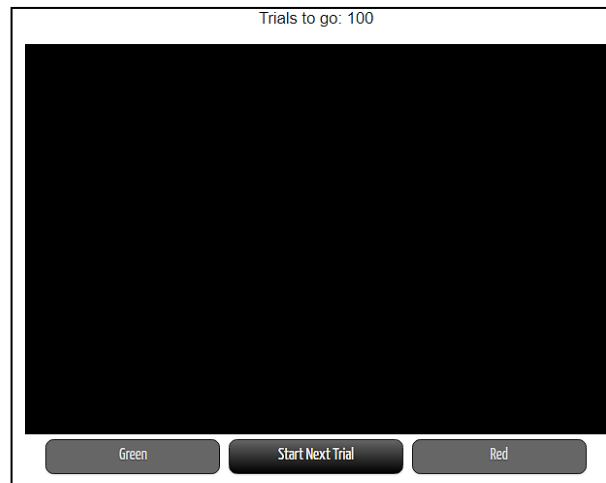
## **RESEARCH METHOD**

In this quantitative experimental study named "Simon Effect", 24 postgraduate students (12 males and 12 females) in a Malaysian public research university were used as samples to test whether or not gender plays a role in tracking accuracy. The research design would be an experimental design where it would be a one-shot case study with one group of participants who will participate in an experiment simultaneously, but the comparison will be between male and female participants. The sample will be chosen by using the quota sampling technique, which is under non-probability sampling, where this study will focus only on postgraduate students of UPM.

Cengage Learning Asia Pte. Ltd designed and produced a software called "Simon Effect," which was used in this experiment. The tracking accuracy of the sample is determined by recording and analyzing the results of 100 tests using the "Simon Effect" as the experimental principle. The specific validation procedure is described following.

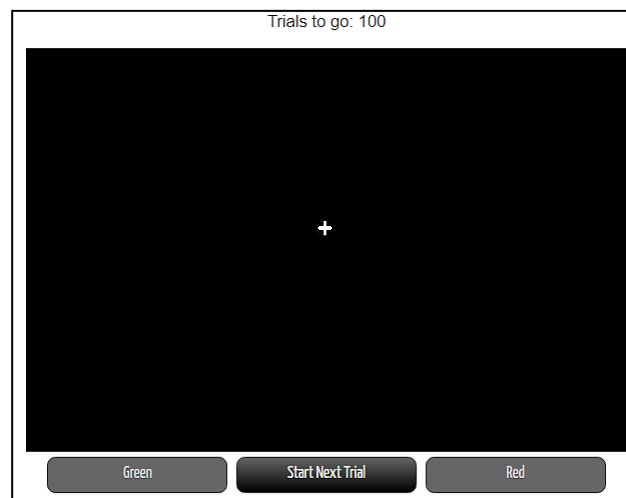
Firstly, the instructions and the black color box will appear as seen in Figure 2. when participants reach the experiment web page. To begin the experiment, participants should click the 'Start next trial' button. The experiment will take about 30 minutes to complete. Secondly, as the experiment begins, the fixation point appears and then vanishes as shown in Figure 4. After a random period, the participants will be presented a red or green square to the left or right of the fixation dot (Figure 4). Their goal is to determine if the square is red or green as fast as possible. If they make a mistake (for example, reporting a green square as a red square), the trial will be replayed. There are at least 100 trials.

**Figure 2.** The Black Box Appeared Before The Experiment Begin



After the 100 trials, the mean response time (RT) in milliseconds (ms) will be shown to the participants as result. The RT (ms) will be used to analyze the results as the results will be analyzed through SPSS software version 26.

**Figure 3.** Appearance Of Fixation Point

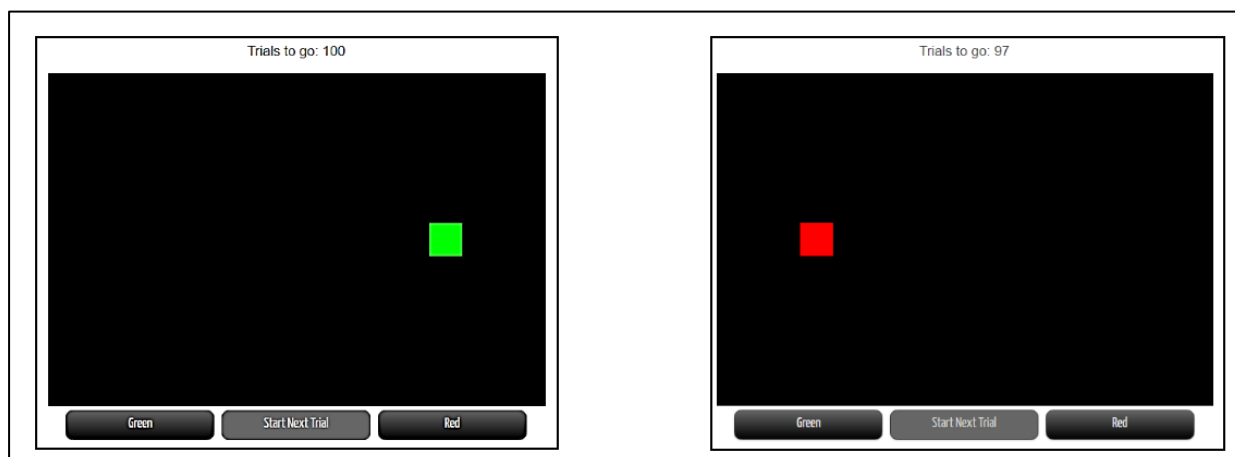


## RESULTS & DISCUSSION

### *Tracking accuracy between male and female students*

A total of 24 participants have participated in this experimental study voluntarily. The number of participants was equal by gender where there was a total of 50% of male participants (n=12), followed by 50% of female participants (n=12).

**Figure 4.** Appearance Of Red And Green Square



**Figure 5.** Responding Time (Rt) Of Male And Female Students For Congruent Stimulus

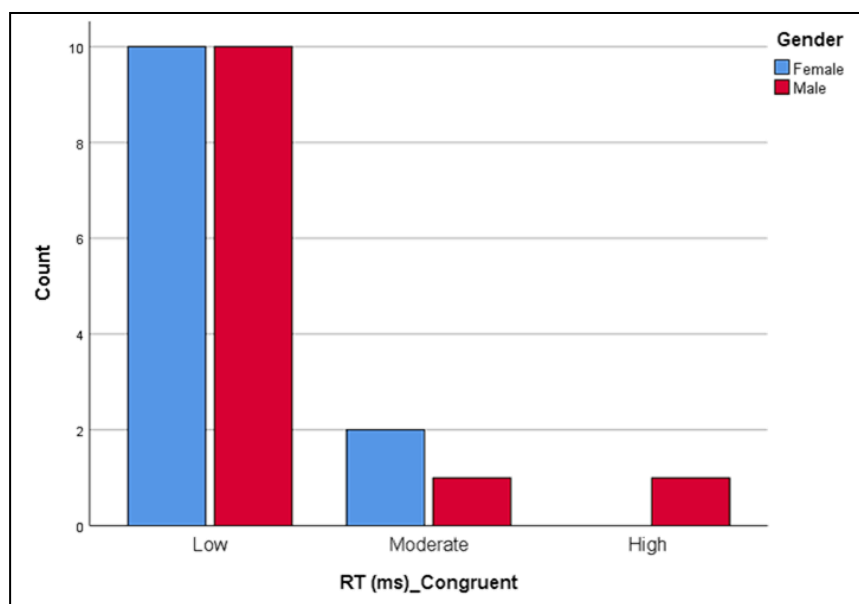


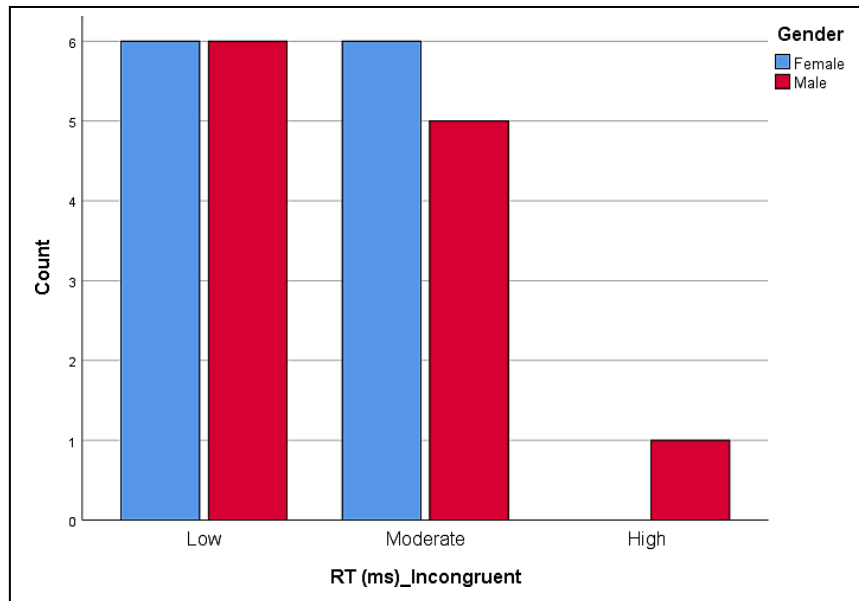
Chart 1 shows male and female students' responding time (RT) to the congruent stimulus. According to the chart above, one of the male participants recorded higher RT (ms) compared to female students to respond to a congruent stimulus which indicates male students took higher RT (ms) for the familiar stimulus or like the color shown

Chart 2 shows male and female students' responding time (RT) to the incongruent stimulus. According to the chart above, still one of the male participants recorded higher RT (ms) compared to female students to respond to an incongruent stimulus which indicates male



students took higher RT (ms) when the complexity of the experiment increases when incongruent stimulus is shown. However, an analysis using SPSS was conducted to prove this result.

**Figure 6.** Responding Time (Rt) Of Male And Female Students For Incongruent Stimulus



As hypothesis 1 predicted that there is a significant difference in tracking accuracy of male and female postgraduate students in Universiti Putra Malaysia (UPM), an Independent T-Test was used to analyze the result for hypothesis 1.

**Table 1.** Results Of Independent-Sample t-Test On Tracking Accuracy By Students' Gender

Students' Gender	<i>n</i>	Mean	SD	<i>t</i>	<i>p</i>
Male	12	1372.1200	140.87070	-.406	.688
Female	12	1406.9767	261.51626		

The total mean time to complete the experiment (ms) was used as an independent variable in the test to represent the tracking accuracy. As depicted from Table1, there was no significant difference,  $t(22) = -.406$ ,  $p = .688$  at .05 level of significance. Meantime taken to

complete the experiment for male students ( $M = 1372.1200$ ,  $SD = 140.87070$ ) was slightly lower for mean time taken by female students ( $M = 1406.9767$ ,  $SD = 261.51626$ ). The effect ( $d$ ) was calculated using the formula below:

$$d = t \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$$

The  $t$  represents the t-value mentioned above and  $n_1$  and  $n_2$  represents the number of male and female students, respectively. So, effect ( $d$ ) was  $-.1657$ , indicating a trivial effect. So, the results fail to support the conclusion that the tracking accuracy between male and female postgraduate students of Universiti Putra Malaysia was significantly different.

### **Relationship between stimulus complexity, familiarity, and tracking accuracy**

Hypothesis 2 predicted a significant relationship between stimulus complexity and tracking accuracy of postgraduate students of Universiti Putra Malaysia, whereas hypothesis 3 predicted that there is a significant relationship between familiarity and tracking accuracy of postgraduate students of Universiti Putra Malaysia. So, these hypotheses were analyzed through Pearson Correlation and the results as below:

**Table 2.** Results Of Pearson Correlation Between Selected Factors And Tracking Accuracy

<b>Factors</b>	<b>r</b>	<b>p</b>
Stimulus Complexity	.705	.000**
Familiarity	.473	.019*

*Note: \*\* significant at .01 level*

*\* significant at .05 level*

To represent the stimulus complexity, the responding time (RT) of participants for incongruent stimulus was used. According to the results in table 2, there was a positive and high relationship between stimulus complexity and tracking accuracy of postgraduate students in

Universiti Putra Malaysia and the correlation was significant,  $r(22) = .705$ ,  $p < .01$ . Besides, there was a positive and moderate relationship between familiarity and tracking accuracy of postgraduate students in Universiti Putra Malaysia and the correlation was significant,  $r(22) = .473$ ,  $p < .05$ .

### ***Discussion***

According to the Independent T-test results shown above, there is no significant difference in tracking accuracy of male and female postgraduate students which is opposite to Merritt, et al.(2007), where he explored that both male and female participants succeed to be attentive when the stimulus is familiar to them. Somehow, male participants are more attentive compared to female participants when the task becomes complex (Merritt, et al., 2007). When it comes to this study, the participants were not observed time to time while participating in the experiment. That is why the results shown in chart 1 and 2 is differed from the past studies. The chart shown in the result explained that there is difference in time taken to respond to stimulus according to the familiarity and stimulus complexity. So, as past results indicates that gender not always influence the tracking accuracy because other factors influence the participants to be distracted from the tasks such as environment and their own interest.

In addition, the Pearson correlation results supported the prediction where there is a significant relationship between stimulus complexity, familiarity, and tracking accuracy. It is similar to the result of a past study by Hyona, Oksama, & Rantanen (2020) where the familiarity and stimulus complexity do affect the tracking accuracy and this past study used words to indicate the stimulus complexity and familiarity by the length of the words and current study used the color and position of the colored shapes to indicate those factors (Hyona, Oksama, & Rantanen, 2020).

Eventhough, the main task was to pay attention to the colors of the squares and respond accordingly, people are almost always affected by the position of the square as well. When the square's position and the corresponding keypress's location have the same relative position (Goldstein, 2019). For example, a green square on the left side of the screen will make the

participants' response time faster than when the red square is on the left side of the screen, which is opposite to the location of the corresponding key or button. So, the participants tend to respond faster when the stimulus appeared on the same of side the matching key which made the participants familiar with . So, the familiar information will be stored easier, and their attention will be fixed to the color of the square and the key buttons. So, when the position of squares started to change, which made the whole thing complex, their attention will be divided where there must focus on the color and the squares' position, which made them respond slower.

In summary, two important suggestions can be made. The first one is the type of information that is being exposed by the students several times. It can be a 'mere exposure effect' and can be implemented during lecture hours. They will be more engaged in the classrooms. We may hear and study about different teaching strategies that can be applied in schools, however, when comes to university, the lecture hours should be more interesting if the lecture's explanation is less complex. and they use different ways such as having a quiz, asking questions, projecting flashcards, playing educational games and group discussions to give the same input to the students which will make the online learning enjoyable without causing any divided attention from the learners as well.

## **CONCLUSION**

The current study investigated the effects of stimulus complexity and familiarity on tracking accuracy among Malaysian male and female postgraduate students. A group of findings indicate that gender does not affect postgraduate students' tracking accuracy. However, stimulus complexity and familiarity influences postgraduate students' tracking accuracy. These findings have also provided a great deal of guidance and application to our teaching and learning processes. The complexity of the stimulus, for example, can affect tracking accuracy. It motivates teachers to pay more attention to the color collocation of courseware while designing course materials, result in better visual stimulation experience for students. Furthermore, based on familiarity findings, teachers can use traditional teaching strategies in the classroom interaction session to

enhance students' participation and initiative in classroom interaction, while avoiding students' tension and discomfort in new classroom education strategy activities.

## REFERENCE

- Alqahtani, F. (2019). Investigating the Effect of Structure Complexity on Students' Recognition of the Subject Slot. *International Journal of Linguistics, Literature and Translation*, 2(6), 77–82. <https://doi.org/10.32996/ijllt.2019.2.6.10>
- Benbunan-fich, R., & Hiltz, S. R. (2003). Mediators of the Effectiveness of Online Courses. *IEEE Transactions on Professional Communication*, 46(4), 298–312. <https://doi.org/10.1109/TPC.2003.819639>
- Cole, M. T., Shelley, D. J., & Swartz, L. B. (2014). Online Instruction, e-Learning, and Student Satisfaction: A Three Year Study. *The International Review of Research in Open and Distributed Learning*, 15(6). doi:<https://doi.org/10.19173/irrodl.v15i6.1748>
- Dhawan, S. (2020). Online Learning: A Panacea in the Time of COVID-19 Crisis. *Journal of Educational Technology Systems*, 49(1), 5–22. <https://doi.org/10.1177/0047239520934018>
- Dosher, B. A., Jeter, P., Liu, J., & Lu, Z. (2013). An Integrated Reweighting Theory of Perceptual Learning. *Proceedings of the National Academy of Sciences of the United States of America*, 110(33), 13678–13683. <https://doi.org/10.1177/0047239520934018>
- Global, I. (n.d.). *What is Stimulus Complexity \_ IGI Global*. Retrieved January 24, 2022, from <https://www.igi-global.com/dictionary/stimulus-complexity/36865>
- Goldstein, E. B. (2015). *Cognitive Psychology: Connecting Mind, Research, and Everyday Experience* (Fourth.). Cengage Learning.
- Huang, Q., Veeraraghavan, A., & Sabharwal, A. (2017). TabletGaze: Dataset and Analysis for Unconstrained Appearance-Based Gaze Estimation in Mobile Tablets. *Machine Vision and Applications*, 28(5), 445–461.
- Hyönä, J., Oksama, L., & Rantanen, E. (2020). Tracking the Identity of Moving Words: Stimulus Complexity and Familiarity Affects Tracking Accuracy. *Applied Cognitive Psychology*, 34(1), 64–77. <https://doi.org/10.1002/acp.3589>
- Li, J., Oksama, L., & Hyönä, J. (2019). Model of Multiple Identity Tracking (MOMIT) 2.0: Resolving the Serial vs. Parallel Controversy in Tracking. *Cognition*, 182, 260–274. <https://doi.org/10.1016/j.cognition.2018.10.016>
- McQuirter, R. (n.d.). *Lessons on Change: Shifting to Online Learning During COVID-19*. Retrieved January 24, 2022, from <https://journals.library.brocku.ca/brocked>
- Merritt, P., Hirshman, E., Wharton, W., Stangl, B., Devlin, J., & Lenz, A. (2007). Evidence for Gender Differences in Visual Selective Attention. *Personality and Individual Differences*, 43(3), 597–609. <https://doi.org/10.1016/j.paid.2007.01.016>
- Mindtap. (2020). *CogLab: The Online Cognition Lab*. Cengage Learning Lte. Ptd.

- Oksama, L., & Hyönä, J. (2016). Position Tracking and Identity Tracking Are Separate Systems: Evidence from Eye Movements. *Cognition*, 146, 393–409. <https://doi.org/10.1016/j.cognition.2015.10.016>
- Ponce, H. R., Mayer, R. E., & Loyola, M. S. (2020). Effects on Test Performance and Efficiency of Technology-Enhanced Items: An Analysis of Drag-and-Drop Response Interactions. *Journal of Educational Computing Research*, 59(4), 713–739. <https://doi.org/10.1177/0735633120969666>
- Roe, A., Blikstad-balas, M., & Dalland, C. P. (2021). The Impact of COVID-19 and Homeschooling on Students' Engagement With Physical Activity. *Frontiers in Sports and Active Living*. <https://doi.org/10.3389/fspor.2020.589227>
- Shuyang, Z. (2021, April 2). 2021 2nd International Conference on Big Data and Informatization Education. Retrieved January 24, 2022, from <https://ieeexplore.ieee.org/abstract/document/9457450>
- Stewart, E. E. m., Valsecchi, M., & Schütz, A. C. (2020). A Review of Interactions between Peripheral and Foveal Vision. *Journal of Vision*, 20(2). <https://doi.org/10.1167/jov.20.12.2>
- Susac, A., Planinic, M., Bubic, A., Jelicic, K., Ivanjek, L., Cvenic, K. M., & Palmovic, M. (2021). Effect of Students' Investigative Experiments on Students' Recognition of Interference and Diffraction Patterns: An Eye-Tracking Study. *Physical Review Physics Education Research*, 17(1). <https://doi.org/10.1103/physrevphyseducre.17.010110>
- Yavari, Fereshteh, Shafiee, & Sajad. (2019). Effects of Shadowing and Tracking on Intermediate EFL Learners' Oral Fluency. *International Journal of Instruction*, 12(1), 869–884. <https://doi.org/10.29333/iji.2019.12156a>