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TASK COMPLEXITY MODULATES GENDER DIFFERENCES IN REACTION TIME: AN EXPERIMENTAL STUDY

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ABSTRACT

This study examined gender differences in reaction time (RT) under simple and choice experimental conditions among 100 undergraduate students (49 males, 51 females) recruited via convenience sampling from different areas of Karachi. Using a between-groups experimental design, participants completed either a simple RT task (identifying a single target color among six alternatives) or a choice RT task (selecting any color according to preference), with response latency recorded manually by stopwatch. Independent-samples t-tests revealed no significant difference in RT between the simple and choice conditions. Gender comparisons, however, showed a condition-specific pattern: in the simple condition, females responded significantly faster than males, whereas no significant gender difference emerged in the choice condition. These findings suggest that gender-related differences in RT are not uniform but depend on task demands, with the additional decision-making component of choice tasks appearing to attenuate the gender gap observed under simpler conditions. Methodological limitations and directions for replication are discussed.

I. INTRODUCTION

The efficiency of the perceptual, attentional, and motor processes that transform sensation into action is reaction time (Roopashree et al., 2021). Reaction time is defined as "*the total time that elapses between the presentation of a stimulus and the occurrence of a response in a task that requires a participant to perform an elementary behavior (e.g., pressing a key) whenever a stimulus (such as a light or tone) is presented*" (American Psychological Association, 2018). Simple reaction time is a combination of one stimulus and one predetermined response and, hence, has the least demand on decision-making. Choice reaction time is a multiple stimulus-response option and requires stimulus discrimination and response selection, followed by the action execution (Плохіх & Яновська, 2022). The more choices, the more perceptual uncertainty, or the time pressure of a task, systematically increase latency (Ansado et al., 2024; Qiao et al., 2026). Reaction time is a multi-dimensional measure of processing speed. It represents the total time it takes for the detection of a stimulus, perceptual processing, decision making, and motor execution. Thus, any individual or group difference in reaction time could be due to a difference in processing speed at one of these stages rather than in overall general processing speed (Bianco et al., 2020; Nanova et al., 2022).

Gender has been studied many times as a cause of difference in reaction time, but its effect seems to be inconsistent. A few studies have found that males have lower latencies on simpler or time-constrained measures of response, others have found that females are equal and even superior in accuracy and consistency, and others have found that sex differences in healthy samples are negligible or absent (Bianco et al., 2020; Плохіх & Яновѕka, 2022; Gautam, 2023; Shankaregowda et al., 2022). The differences in simple and choice reaction time between males and females may be due to sensorimotor processes or to the additional decision-making processes involved in response selection (Bianco et al., 2020; Ansado et al., 2024). Knowing these differences can be useful in situations where quick and precise responses are critical. Evidence for sex difference in simple reaction time is inconsistent. Several chronometric studies have shown that male latencies on simple sensorimotor tasks are less (Плохіх & Яновська, 2022; Dodig et al., 2020). However, other studies report the opposite or null results: females are slower to visual reaction time than males in some samples (Roopashree et al., 2021); females are faster to visual stimuli than males (Bari & Aldosky, 2022); or no reliable sex difference in simple auditory or visual latency (Shan et al., 2022; Shankaregowda et al., 2022). This heterogeneity suggests that a simple-task difference is sensitive to sensory modality, sample property, and sensitivity of the measure, rather than male vs. female. The choice reaction time is also a conditional reaction and shows a tendency to a speed-accuracy rather than a gender difference. Females tend to be more accurate or consistent, and males more reactive or fast. This difference has been suggested from an electrophysiological perspective to be due to more proactive and cautious processing in females (Bianco et al., 2020). A few cognitive-motor integration paradigms do not show any correlation between gender and reaction time even with a high level of task difficulty (Chou et al., 2022).

Hypotheses

1. Reaction time will differ significantly between the simple and choice reaction time conditions.
2. Male and female participants will differ significantly in simple reaction time.
3. Male and female participants will differ significantly in choice reaction time.

II. METHOD

This study employed a between-groups experimental design to examine differences in reaction time between simple and choice conditions. Participants were assigned to one of two experimental groups: a simple reaction time condition or a choice reaction time condition. The independent variable was reaction-time condition (simple vs. choice), and the dependent variable was participants' reaction time, measured in seconds.

Participants

The sample consisted of 100 undergraduate students (49 males, 49.0% and 51 females, 51.0%) were convenience sampled from different areas of Karachi. In terms of birth order, 44 participants (44.0%) were firstborn, 44 (44.0%) were middle born, 9 (9.0%) were last-born, and 3 (3.0%) were only child. Most of the participants were not employed (77.0%) and only 23.0% were employed. Most had undergraduate or graduate degree (93.0%) and the rest had intermediate education or less (7.0%). There was a voluntary participation, and verbal consent was taken before collecting the data.

Measures

Reaction time was recorded in seconds using a stopwatch in both conditions. Responses were logged in a structured spreadsheet capturing participant name, age, gender, birth order, education, occupation, and reaction time.

Procedure

The materials used for testing were an A4 sheet containing six rectangular strips of color equally spaced with an arrowhead denoting the start position. The participants were given verbal consent, informed about the purpose of the study and then put in one of two conditions. The simple reaction time condition required the participants to recognize and choose the yellow strip as fast as possible from the six alternatives. During the choice reaction time condition, the subjects were asked to choose any strip of theirr choice. In both cases, the time taken for the response was timed with a stopwatch. All demographic variables were summarized using descriptive statistics.

Independent-samples t-tests were used to compare the reaction time in simple and choice conditions and compare the gender difference within each condition. In cases where the assumption of homogeneity of variance was found to be violated by Levene's test, the Welch's t-test was used and is reported. The study was ethically approved by the academic department, and the experiment was carried out under the supervision of the course instructor. All participants were asked to participate voluntarily, and the right to withdraw at any time without penalty was explained to the participants. All participants gave verbal consent before the data collection, and the information of the participants was kept confidential throughout the study.

III. RESULTS

Table I: Descriptive Statistics and Independent-Samples t-Test for Reaction Time by Experimental Condition

Condition	*N*	*M*	*SD*	*t*	*df*	*p*	95% CI LL	95% CI UL
Simple	55	3.64	2.88	-1.15	98.00	.254	-1.62	.43
Choice	45	4.24	2.14					

Note. Equal variances assumed. CI = confidence interval of the mean difference between Simple and Choice conditions; LL = lower limit; UL = upper limit.

An independent-samples t-test was conducted to compare reaction time between the Simple (n = 55, M = 3.64, SD = 2.88) and Choice (n = 45, M = 4.24, SD = 2.14) conditions. The results indicated no statistically significant difference between the two groups, t(98) = -1.15, p = .254. The 95% confidence interval for the mean difference ranged from -1.62 to 0.43, which includes zero, further supporting the non-significant result.

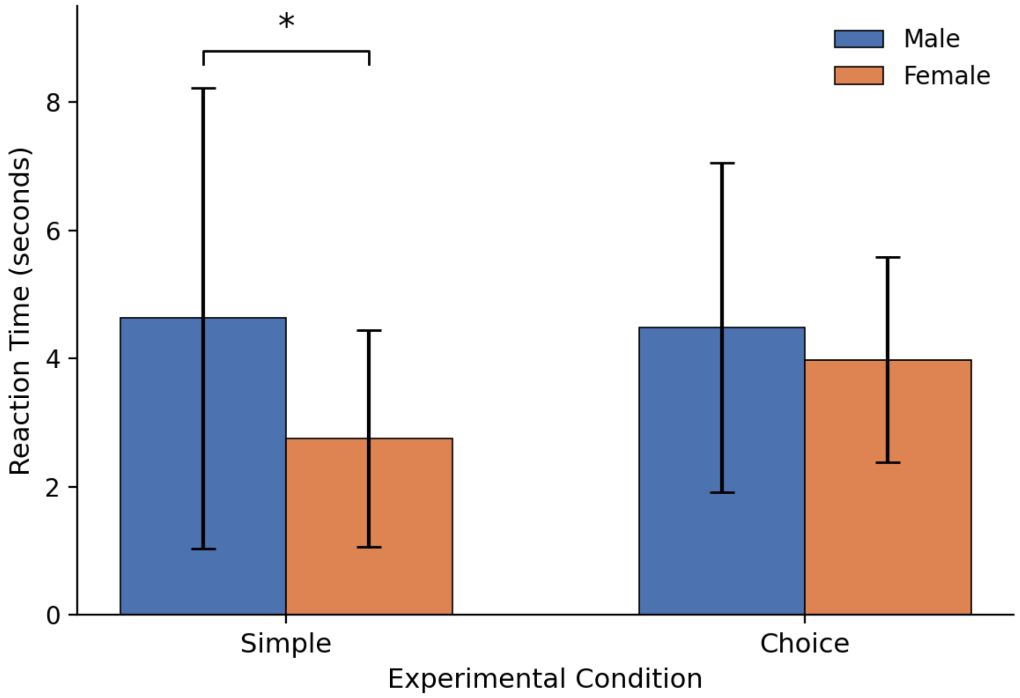
Table II: Independent-Samples t-Test Results for Gender Differences in Reaction Time by Experimental Condition

Condition	Gender	*N*	*M*	*SD*	*t*	*df*	*p*	Cohen's *d*
Simple RT	Male	26	4.63	3.59	2.43*	34.71	.021	.679
	Female	29	2.76	1.69				
Choice RT	Male	23	4.48	2.57	0.80	37.10	.432	.235
	Female	22	3.98	1.60				

Note. M = Mean; SD = Standard Deviation. Welch's degrees of freedom used (equal variances not assumed). Cohen's d uses the pooled standard deviation. $^{*}p < .05$.

Levene's test indicated unequal variances for both the simple, $F = 5.85$, $p = .019$, and choice reaction time conditions, $F = 5.97$, $p = .019$; therefore, Welch's *t*-test was used. In the simple reaction time condition, males ($M = 4.63$, $SD = 3.59$) had significantly longer reaction times than females ($M = 2.76$, $SD = 1.69$), $t(34.71) = 2.43$, $p = .021$, 95% CI [0.30, 3.43], $d = 0.68$. In the choice reaction time condition, males ($M = 4.48$, $SD = 2.57$) also showed longer reaction times than females ($M = 3.98$, $SD = 1.60$); however, the difference was not statistically significant, $t(37.10) = 0.80$, $p = .432$, 95% CI [-0.78, 1.79], $d = 0.24$.

Figure I: Mean Reaction Time by Gender and Experimental Condition



Note. Error bars represent standard deviations. * p < .05.

IV.DISCUSSION

The present study investigated gender differences in simple and choice reaction time, and whether gender differences in performance would differ as a function of task demands or remain stable across tasks requiring different reaction times (Bianco et al., 2020; Qiao et al., 2026). There was no significant difference in reaction time between the two conditions simple and choice. This may have been a result of individual differences in attention, motivation, task familiarity, or the large range of reaction times. The previous studies also show that the sample characteristics, familiarity with the task and sensitivity of the measurement affect the reaction time performance (Gautam, 2023; Shankaregowda et al., 2022). The most important finding of this study was that gender differences varied across tasks and not across task conditions. For the simple reaction time task, there was a significant difference between the response time of females and males; however, there was no significant difference between the response time of the males and females for the choice reaction time task. This result aligns with earlier studies indicating that gender reaction time differences are affected by task difficulty and structure and do not provide a consistent advantage to one sex in all tasks (Bianco et al., 2020; Плохіх & Яновська, 2022). It is also in line with the results of previous studies indicating that gender differences in RT are often small, task-specific, and context-dependent (Yang et al., 2022; Yang et al., 2023).

Notably, there was no significant gender difference between the choice reaction time condition, which supports previous research indicating that stimulus discrimination and response selection result in less gender difference in response speed. The gender differences in reaction times might be reduced or even eliminated when the cognitive load is high and time is limited (Qiao et al., 2026). Likewise, it has been found that there is no consistent gender difference in tasks that involve higher levels of cognitive integration (Chou et al., 2022). However, electrophysiological data also indicate that the males could prepare their responses in a different way than the females and process the stimulus after it is presented in a different way, accounting for the similar overall reaction times in choice tasks (Bianco et al., 2020). In the simple reaction time condition, females exhibited quicker reaction times than males. This is contrary to the studies reporting males' higher sensorimotor response (Плохіх & Яновська, 2022; Dodig et al., 2020), but the studies in which females showed higher sensorimotor response to visual stimuli were under certain conditions (Bari & Aldosky, 2022). Normative studies also have revealed females' superiority in some processing speed tasks (Yang et al., 2022; Yang et al., 2023). A possible explanation is that the simple reaction time task was more of a proactive response style. There have been several studies that have shown that there is no significant difference between males and females in the simple visual or auditory reaction time (Shan et al., 2022; Shankaregowda et al., 2022). Moreover, it is worth noting that there was greater variation in male reaction times in the present study, which aligns with the concern that small or convenience samples may yield unstable estimates of gender differences (Плохіх & Яновська, 2022; Roopashree et al., 2021). The results variability in this study may have been caused by other factors affecting the reaction time, such as the menstrual cycle phase for female participants, sleep and fatigue (Ołpińska-Lischka et al., 2020; Migliaccio et al., 2022; Sawicka et al., 2025).

Limitations

The results of this study should be interpreted with some caution, given the following limitations. First, reaction times were measured with a manual stopwatch, which has inherent human error, experimenter variance, and a lag time before activation of the response that is far less precise than automated and computerized reaction-time measurement. Second, an experimental between-groups design was used, but the distribution of participants across conditions was not balanced (55 were placed in the Simple condition and 45 in the Choice condition). Lastly, in both conditions, the equality of variances test was significant in the gender analyses, again demonstrating violations of the homogeneity of variance assumption, although this was corrected statistically using Welch's t-test, the high variance, especially among males in the simple condition (SD = 3.59), implies that there are individual differences in the data that could not be explained by the data in this study.

Recommendations

Future studies should be based on larger, more representative samples of various ages, educational levels, and work environments to enhance the generalizability of the results. To enhance the internal validity and reliability of the research, the researchers should also consider some confounding factors that may influence the reaction time of the participants such as environmental distraction, lighting, testing time, and participant's fatigue. Convenience sampling within one university was used, which is considered an initial step in the research but in future studies probability sampling methods should be used to reduce sampling bias and increase representativeness. Future studies need to explore the effects of a wider age range and other factors that may affect reaction time performance including sleep quality, stress, cognitive ability, physical activity and caffeine intake. Longitudinal or repeated measures designs would offer more insight into the changes in reaction time over time and would help to control for individual variability. Lastly, the findings from the present study indicate that the gender difference in simple reaction time should be further replicated with balanced gender subgroups, larger sample sizes for each gender subgroup, and automated, computerized timing of the reaction time to establish whether the gender effect is a reliable, generalizable effect.

V. CONCLUSION

The findings of the present study suggest that there is no consistent gender difference on reaction time; the differences observed may be related to the type of task and/or its cognitive demands. Females exhibited significantly faster reaction times than males when performing the simple reaction time task, but there was no significant difference between the two genders for the choice reaction time task, which included an additional response selection and decision-making. These results indicate that gender differences in reaction time are context specific, and do not imply a general reaction time advantage. This is similar to previous findings that the cognitive strategy, preparatory processes, and task complexity have effects on reaction time performance but not inherent processing-speed differences between the sexes (Bianco et al., 2020; Qiao et al., 2026). The findings overall support the existing literature indicating that there is a need to consider differences in cognitive performance between the sexes in relation to the specific task demands.

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