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Expert Swimmers' Reaction Time on Auditive Stimuli is depending on Running Speed

Die Reaktionszeit auf auditive Stimuli bei Profi-Schwimmern ist abhängig von der Laufgeschwindigkeit

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Summary

- › **Background:** Reaction time plays an important role in swimming competitions and in saving lives as a lifeguard: only a small delay in response to auditory stimuli can mean first or second place in competitions or success in saving lives. The purpose of this study was to compare expert swimmers' reaction times at preferred and non-preferred running speeds.
- › **Methods:** Twenty expert, female swimmers with mean age of 27.84 years (SD: 5.56) were instructed to run at their own preferred speed for 50 m on a treadmill. Then they ran the same distance 30% slower and 30% faster than their own preferred speeds. In order to examine swimmers' attentional demands while running, their vocal reaction time, following an auditory stimulus, was measured by Audacity software. The interval between stimulation and the first response was calculated as swimmer's reaction time.
- › **Results:** An analysis of variance with repeated measures revealed that reaction time at a slow pace (0.542 ± 0.023 s) was faster than at the preferred speed (0.646 ± 0.08 s; $P \leq 0.001$).
- › **Conclusion:** When running on a treadmill, swimmers focus their attention on maintaining their balance; that is why at slower speeds more attention can be directed to the auditory stimulus, resulting in shorter reaction times. In addition, these results indicate that changing movement planes (horizontal plane versus sagittal plane) can affect the level of skills in expert swimmers and lifeguards.

Zusammenfassung

- › **Hintergrund:** Die Reaktionszeit spielt eine wichtige Rolle bei Schwimmwettbewerben und bei der Rettung von Menschenleben: Nur eine geringe Verzögerung bei der Reaktion auf auditorische Reize kann den ersten und zweiten Platz bei Wettbewerben oder bei der Rettung von Menschenleben verändern. Ziel dieser Studie war es, die Reaktionszeiten von erfahrenen Schwimmerinnen bei bevorzugten und nicht bevorzugten Laufgeschwindigkeiten zu vergleichen.
- › **Methoden:** 20 erfahrene Schwimmerinnen mit einem Durchschnittsalter von 27,84 Jahren (SD: 5,56) wurden angewiesen, 50 m lang auf einem Laufband mit ihrer eigenen bevorzugten Geschwindigkeit zu laufen. Dann liefen sie die gleiche Strecke 30% langsamer und 30% schneller als ihre eigenen bevorzugten Geschwindigkeiten. Um die Aufmerksamkeitsanforderungen der Schwimmer beim Laufen zu untersuchen, wurde ihre Reaktionszeit auf einen auditorischen Reiz mit der Audacity-Software gemessen. Das Intervall zwischen Stimulation und der ersten Reaktion wurde als Reaktionszeit des Schwimmers berechnet.
- › **Ergebnisse:** Eine Varianzanalyse mit wiederholten Messungen ergab, dass die Reaktionszeit bei langsamer Geschwindigkeit ($0,542 \pm 0,023$ s) schneller war als bei der bevorzugten Geschwindigkeit ($0,646 \pm 0,08$ s; $P \leq 0,001$).
- › **Fazit:** Auf dem Laufband konzentrieren sich die Schwimmer auf die Aufrechterhaltung des Gleichgewichts; deshalb kann bei langsameren Geschwindigkeiten mehr Aufmerksamkeit auf den auditorischen Reiz gerichtet werden, was zu kürzeren Reaktionszeiten führt. Darüber hinaus deuten die Ergebnisse darauf hin, dass die Veränderung der Bewegungsebenen (horizontale Ebene vs. sagittaler Ebene) das Niveau der Fähigkeiten von erfahrenen Schwimmern und Rettungsschwimmern beeinflussen kann.

KEY WORDS:

Attentional Demands, Movement Plane, Swimming, Running Speed, Secondary Task

SCHLÜSSELWÖRTER:

Aufmerksamkeitsanforderungen, Bewegungsebene, Schwimmen, Laufgeschwindigkeit, Mehrfachaufgabe

Introduction

It has previously been argued that attentional demands increase when walking with increased task complexity (1). Few studies have examined attentional demands at different walking speeds (preferred and non-preferred) (1, 5, 8). Abernethy et al. (1) revealed that simple reaction time increased during fast walking. In another study, Kurosawa (5) concluded that mean reaction time at the speed of 4 km/h increased at faster or slower walking speed. However, another study found no significant differences in reaction time between preferred and non-preferred (slower) walking speeds (12).

The interval between stimulation and the first response is called reaction time (17). Because reaction time plays an important role in swimming competitions and also in saving lives as a lifeguard, only a small delay in response to auditory stimuli changes the first and second places in competitions or saving a person's life (2,18), so it is very important to examine swimmers' attentional demands and their reaction time in different situations. Contradictions between the conclusions of different studies on walking and attentional demands at different speeds of running revealed this question, i.e., whether different



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running speeds in swimmers (preferred, 30% slower and 30% faster) affect reaction time.

Methods

In this cross-sectional study, the participants consisted entirely of swimmers who had acquired a lifeguard degree in Alborz province, Iran, and their ability was at provincial level. After notifying regional swimming coaches and swimmers, twenty female subjects (mean age: $27.84 \pm \text{SD}: 5.56$ yrs.) were selected randomly from swimmers and lifeguards who had at least five years of work experience. Before entering the study, the subjects declared their consent to participate in the study. A Tunturi treadmill t8 was used to test running, a speaker (NEC brand) was used to play a pistol sound and Audacity software was applied to record sound.

Procedure

Before data collection, the subjects were verbally instructed on how to use the treadmill (Tunturi, T8, Netherlands), and respond to the auditory stimulus, which was the sound of a pistol. This study was conducted over three consecutive days. On the first day, the study subjects were asked to run a 50-m distance three times on the treadmill at their own preferred speed. The speeds of all three trials were recorded and the mean speed calculated (6). Then, they ran at speeds 30% faster and 30% slower than their preferred speed. This was also calculated and recorded.

On the second day of the study, subjects trained at their non-preferred speeds 3-8 times before the test and had a 30-sec rest interval between each of two trials. On the third day of the study, subjects were asked to run a 50-m distance on the treadmill at 1) their preferred speed, 2) 30% slower and 3) 30% faster. At the sound of the pistol subjects had to respond with the word "TOP". The pistol sounds were played at random time points. The experimenter played the pistol sound 1-3 times over the 50-m run at times when the subjects were almost in the initial swing (10) of their non-dominant leg. The time between auditory stimulus and subject's response was calculated as the reaction time. If more than one stimulus was given, the mean of reaction times was calculated.

Statistical Methods

Descriptive statistics (mean and standard deviation) were used. Repeated Measures ANOVA was used for data analysis of slow, preferred and fast speeds at a significance level of $P \leq 0.05$. Post hoc Bonferroni was used for multiple comparison tests. SPSS version 16 software and Excel software 2007 were applied to draw charts.

Results

Table 1 shows the means of reaction time and standard deviation (SD) at preferred and non-preferred speeds. First, Mauchly's test of sphericity indicated that the assumption of sphericity

Table 1

The mean of reaction time and standard deviation (SD) at preferred speed, 30% slower and 30% faster in swimmers.

	MEAN (SEC)	SD
Preferred Speed	0.646	0.08
30% Slower	0.542	0.02
30% Faster	0.581	0.11

had been violated $\chi^2(2)=.972, p=.775$. Then, ANOVA with a repeated measures determined that mean reaction time differed significantly between preferred and non-preferred speed ($F(2, 38)=7.455, P=0.002$). Post hoc tests using the Bonferroni correction revealed that reaction time at preferred speed was slower ($0.646 \pm 0.08s$) compared to the 30% faster speed ($0.581 \pm 0.11s$) though not statistically significant ($P=0.528$). However, reaction time was significantly reduced at 30% slower speed ($0.542 \pm 0.023s$) compared to the preferred speed ($P=0.001$), but there was no significant difference between 30% slower speed and 30% faster speed ($P=0.107$).

Therefore, it can be concluded that RT was significantly reduced in expert swimmers. RT reduced significantly when they ran on the treadmill at a speed slower than their own preferred speed. RT at 30% faster speed was also reduced but this reduction was not significant.

Discussion

This study examined the effect of different running speeds on expert swimmers' reaction time. Results revealed that RT was increased at fast and preferred running speeds while it was decreased at low speed (Table 2). Because no research on attentional demands in running has been published thus far, the results were compared to existing research on gait patterns. One method to measure attentional demands in simple motor skills is to measure probe reaction time (16).

Probe reaction time could show attentional demands in primary tasks such as walking and running (14). Probe reaction time has been measured by means of vocal response to assess changes in attentional demands in voluntary movements (9). In previous studies, walking has been considered as an automatic movement in human beings. It has attracted more scholars' attentions to find out the mechanism in motor performance studies in comparison with other motor activity (8). Scientists have concluded that energy expenditure is at its lowest when walking at a speed of 3.6 to 4.8 km/h while walking at faster (more than 4.8km/h) and slower (less than 3.6km/h) speeds increases energy expenditure (15). Kurosawa in his study showed that the two factors 1) walking speed and 2) individual had significant effects on reaction time (5). Previous research revealed that RT increased at non-preferred walking speeds (13). These results are in line with the present results at fast speed, while the present results were different from past research at slow non-preferred speed (13). ➤

Table 2

Comparison of reaction time of swimmers at their preferred speed, and at 30% slower and 30% faster. *. The mean difference is significant at the 0.05 level.

		MEAN DIFFERENCE (I-J)	STD. ERROR	SIG
Preferred Speed	30% Slower	0.065	0.029	0.107
	30% Faster	0.104*	0.025	0.001
30% Slower	30% Faster	0.040	0.028	0.528

Walking at low speeds has shown a reduced lateral balance (3,11) and an increase in attentional demands (3) as well as in energy expenditure (4); showing that walking at low speeds resulted in a higher demand in balance skills (18).

Contrary to our hypothesis, running at slow speeds decreased the reaction time. In dual-task interference designs there is limited attention capacity, meaning the attention must be directed to a primary and a secondary task (20). Given that our subjects were expert swimmers, they were expected to show better performance at their preferred speeds, because basic running and swimming patterns are somehow similar in leg movement (19). However, it was observed that swimmers reacted faster to auditory stimulus at the slower speed.

This conflict may be attributed to different movement positions in swimming and running. They both occurred in horizontal plane but in different positions (5). Balance organs located in ears, eyes and feet have their own positions in each plane, and the moment swimmers initiate to run at various speeds, is apparently an unfamiliar task, which requires a lot of attention to perform correctly. To explain the results, it was assumed that as the subjects were lifeguards and competitive swimmers, they chose relatively high speeds on the treadmill (9.10 ± 0.56 km/h) as their own preferred speeds, but when a second task was added, they focused on adjusting their movements and maintaining their balance on the treadmill. They had to maintain their speed and fear of falling forced them to pay more attention to the motor demands of the task while secondary tasks received less attention (7).

If it is accepted that swimmers were novices in this study, another reason for these results may be explained by a difference in the communication between the brain and spinal cord while performing well-learned skills and skills that are being learned. It is hypothesized that well-learned skills are controlled at lower control centers at the spinal cord level. It means that when receptors receive a motor command, these commands receive a response at the spinal cord level from a central patterns generator.

In that case, the response time is much shorter than when the movement needs to receive commands from the upper centers of the brain (7). Therefore, it may be concluded that swimmers need to receive commands from upper levels of their brain to maintain their balance and respond adequately to motor demands. This issue could explain these results.

One of the weaknesses of this study may have been the use of a treadmill for the subjects who were experienced swimmers. We suggest using a novice, non-athletes to conduct similar studies on. Regarding the study and its results, it is suggested that the reaction time of swimmers should be studied in a swimming environment in order to adapt these findings to the study population of the current study. It would also be interesting to examine if reaction times on the treadmill are comparable to reaction times in a starting block run.

Overall, the results of this study, despite the mentioned limitations, showed that the speed of motor performance is not always a disruptive factor in the reaction time of a secondary task. Also, due to the reduced attention demand at a slow speed or rapid response due to lack of involvement of the upper regions of the brain, it is suggested to educators, that in order to reduce the reaction time of secondary tasks, the athletes should choose less than their preferred speed during running. ■

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Conflict of Interest

The authors have no conflict of interest.

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