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Effect of Different Body Postures on Prospective Time Perception

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Abstract

Aim: The current study employed the Time Reproduction task within the Prospective Time Perception paradigm. Previous research has indicated that posture has a consequential influence on time perception. To expand upon these observations, we explored the impact of five distinct postures on participants' time perception.

Methods: During each 8- to 10-minute session, 19 healthy young adults were presented with 50 audio stimuli, which took the form of 'beep' sounds and lasted 0.5, 1, 3, 4, and 6 seconds, in a random order. Participants were instructed to reproduce the duration of the stimuli in five different postures in the following order: sitting, standing, lying supine at 180 degrees, lying head down at -15 degrees (HDT), and lying prone at 180 degrees.

Results: In all postures, the shorter durations were perceived as longer than they are, and the relatively longer durations were perceived as shorter than they are. Statistically significant differences were found between the postures for all stimuli durations except for 3000 ms (repeated-measures ANOVA, significance level at $p < 0.05$). The physically and mentally healthy participants perceived time more slowly when they adapted a lying posture (supine, prone, and -15 degrees HDT) without cognitive load.

Conclusion: The current investigation is the first to examine the influence of these postures (sitting, standing, and the three different lying postures) on the perception of time, with the lying postures, but especially the HDT and prone positions, causing a significant dilation of the perception of time.

Keywords

Time Reproduction, Prospective Time perception, Posture.

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Farklı Vücut Postürlerinin Prospektif Zaman Algısı Üzerindeki Etkisi

Özet

Amaç: Bu çalışmada, "Prospektif Zaman Algısı" paradigması kapsamında "Zaman Yeniden Üretimi" görevi kullanılmıştır. Önceki araştırmalar, postürün zaman algısı üzerinde önemli bir etkisi olduğunu göstermiştir. Bu gözlemleri genişletmek için, beş farklı postürün katılımcıların zaman algısı üzerindeki etkisi araştırılmıştır.

Yöntem: Her 8 ila 10 dakikalık seans sırasında, 19 sağlıklı genç katılımcıya rastgele bir sırayla 0.5, 1, 3, 4 ve 6 saniye süren ve 'bip' sesi şeklinde olan 50 sesli uyaran sunulmuştur. Katılımcılardan uyaranların süresini beş farklı postürde şu sırayla tekrarlamaları istenmiştir: oturma, ayakta durma, 180 derecede sırtüstü yatma, -15 derecede baş aşağı yatma (HDT) ve 180 derecede yüzüstü yatma.

Bulgular: Tüm postürlerde, kısa süreler olduğundan daha uzun, nispeten daha uzun süreler ise olduğundan daha kısa olarak algılanmıştır. 3000 ms hariç tüm uyaran süreleri için postürler arasında istatistiksel olarak anlamlı farklılıklar bulunmuştur (tekrarlı ölçümler ANOVA, anlamlılık düzeyi $p<0,05$). Fiziksel ve zihinsel olarak sağlıklı katılımcılar, bilişsel yük olmaksızın yatar pozisyona (sırtüstü, yüzüstü ve -15 derece HDT) geçtiklerinde zamanı daha yavaş algılamışlardır.

Sonuç: Mevcut araştırma, bu postürlerin (oturma, ayakta durma ve üç farklı yatış pozisyonu) zaman algısı üzerindeki etkisini inceleyen ilk araştırmadır; yatar postürler, özellikle de HDT ve yüzüstü yatma, zaman algısında önemli bir uzamaya neden olmaktadır.

Anahtar Kelimeler

Zaman Yeniden Üretimi, Prospektif Zaman Algısı, Postür.

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INTRODUCTION

The perception of time can be different from its objectively measurable form when the subjective understanding and evaluation of time is in a state of flux (Droit-Volet, 2013). In studies on subjective time perception, researchers have identified two main paradigms: prospective and retrospective (Block, 2003). Researchers have tended to favor prospective time perception in studies involving multiple repetitions of basic stimuli because of the difficulty of studying retrospective time perception using experimental methods. Prospective time perception is commonly associated with attention and is explained by the widely accepted "attention gate model" (Block and Zakay, 1996). In the literature, time

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perception tasks based on this model are categorized into four main types due to variations in type, structure, and characteristics of the measured interval: 'time estimation', 'time comparison', 'time production', and 'time reproduction' (Mioni et al., 2014). Unlike the time production task, the time reproduction task utilized in this study is not suitable for retrospective time perception tasks. This is because participants are expected to attend to the duration they will reproduce (Wearden, 2016). This task may be varied by having participants reproduce either a period of time to which they direct their attention or mark only the beginning and end of the time interval (Grondin et al., 2018).

In this context, it is emphasized that time perception can be altered by both intrinsic and extrinsic factors, and a specific physiological system cannot be considered the key determinant (Block and Zakay, 2001). Time perception is associated with the awareness of time passing and is intricately linked to environmental, psychological, and physiological processes (Wittman, 2013; Allman et al., 2014). A medical study vividly has exemplified this notion: cancer patients with advanced disease perceive time to pass more slowly than cancer patients without symptoms of illness, possibly attributable to variations in levels of distress (Van Laarhoven, 2012).

Time Reproduction Task in Different Postures

Although there is limited literature on the study of time perception in relation to body postures, studies have explored time perception in relation to posture using different movement patterns during exercise. In the context of exercise, research has shown that the perception of time is influenced by a number of variables, including age, gender, body temperature, health and fitness status, mental focus, and intensity of exercise (Behm and Carter, 2020). These studies have contributed to the literature on various aspects of the relationship between exercise and time perception and may provide indirect insight into the effects of posture, although studies of reproductive tasks are much rarer in comparison (Vercruyssen et al., 1989; Tobin ve Gronding, 2012; Tamm et al., 2014; Hanson and Buckworth, 2016)

Edwards and McCormick (2017) examined the perception of elapsed time during cycling in the anaerobic Wingate test, and rowing exercises in a seated posture. The exercise intensity was individually determined. The results of the study showed that elapsed time was perceived to be slower at higher exercise intensities, which was associated with the discharge of catecholamines, leading to greater physical discomfort during intense exercise than during moderate exercise. Not only does the execution of one's own movement leads to the distortion of time perception, but the observation of another's movement can have a similar effect as well. Thus, during observation of upright walking, locomotion speed acts as a form of arousal, and a subjective temporal expansion/slowing was observed in direct proportion to the increase in walking speed, with no effect of walking direction (Karsilar et al., 2018).

In the field of research where body postures are considered variables, Muehlhan and colleagues (2014) conducted a study to investigate the effect of lying and sitting postures on the cognitive abilities of participants. The study demonstrated the influence of posture on cognitive performance in relation to the working memory task, and the participants' reaction times were significantly slower when adopting a supine position. In a study examining the relationship between postures and time perception, nine distinct postures (e.g., standing, bending forward, bending forward while sitting, etc.) were required and the participants were asked to estimate the time elapsed. The results indicated significant differences between the perceived and actual duration (Kumar, 1993).

Furthermore, the research literature contains studies examining postures that participants observe or experience rather than physically perform. Nather et al., (2011) discovered that postures presented by Degas dancer sculptures requiring more movement were perceived to last longer than those requiring less movement. Similarly, Strasser et al. (2005) evaluated time perception while observing the sitting and standing postures of physicians. In the study comprising 69 participants, two groups were randomly assigned to watch two distinct 9.5-minute videos demonstrating physicians transitioning from standing to sitting and vice versa. After watching the videos, participants estimated the length of time that physicians spent with patients. The participants reported that seated physicians spent longer periods of time with their patients compared to standing physicians.

Expanding upon previous research that indicated differences in time perception between standing, sitting, and moving, we investigated the impact of different static postures on time perception. The procedure for this study, which was carried out within the scope of a doctoral thesis, was approved by the ethics committee decision dated 07.02.2020 and numbered 09.2020.254. The study objective was to examine how different body postures affect participants' time perception. To accomplish this task, we defined five different postures: sitting, standing, 180-degree lying supine position, -15-degree head down tilt (HDT) and 180-degree lying prone position (Rice et al., 2013; Cotuk et al., 2020). The participants performed a time reproduction task in the five different body postures using auditory stimuli. Our hypothesis was that these postures would affect time perception during the task.

METHOD

Participants

19 healthy young adults, with an age range of 21 to 32 years and a mean age of 25 years, took part in this research. Prior to participation, subjects were required to have refrained from regular exercise for at least three years, have no hearing impairment, and be university students without any psychiatric or neurological conditions.

Materials

During the five study sessions, auditory stimuli were presented via a desktop computer and headphones (Apple Earpods Headphone Plug) in a sound- and light-isolated room, and participants' behavioral responses to the stimuli were recorded using the left button of the PC mouse. An office chair was utilized in the first session to ensure the participant sat as motionless as possible in an upright posture. No extra equipment was employed during the second session. A tilt table was used for the third, fourth, and fifth sessions of the study (Figure 1).

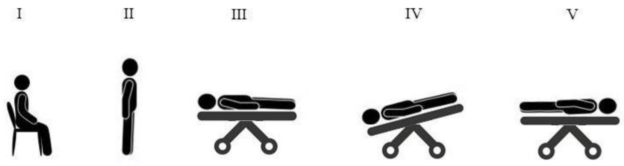

Figure 1. Experimental Postures (Generated Image)

Stimuli

The stimuli were presented to participants through a 400 Hz "beep" sound, which was generated as a sine wave using the MATLAB R2013a software package.

The sound was presented in five durations: 0.5, 1, 3, 4, and 6 seconds. To prevent participants from counting and to reduce the overall duration of the experiment, we chose to use whole time periods rather than intermediate durations as in previous studies. The 500 ms stimulus was included in the study as a halving of the 1-second unit duration, primarily to allow comparison with the 1-second stimulus. Within each set, every stimulus was randomly presented to the participant 10 times. Thus, in each session, participants were presented with a total of 50 sound stimuli in the exact same order. The study's respective phases lasted 8 to 10 minutes, depending on the participants' response times. The entire study lasted 50 minutes, including the times for changing posture. After the stimulus was presented to the participants, they were prompted to reproduce the target duration when they felt ready by holding down the left mouse button and hearing the same tone again. When the participants released the button, the tone ceased, and the subsequent tone was played to the individual following the pause (see figure 2).

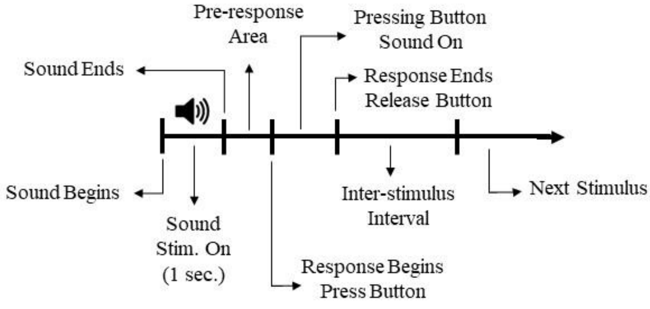

Figure 2. Stimulus Presentation (Generated Image)

Analysis

Time reproduction was recorded during five different postures: sitting, standing, 180-degree lying supine position, -15-degree head down tilt (HDT) and 180-degree lying prone position. The analysis of variance (ANOVA) was conducted on the subjective time differences observed for the five specific stimulus durations and the total time differences found for the five postures using software SPSS-v20.

FINDINGS

In all postures, the shorter durations (500ms and 1000ms) were perceived as longer than they are, and the relatively longer durations (3000ms, 4000ms, and 6000ms) were perceived as shorter than they are (table 1 and figure 3). A repeated-measures ANOVA analysis with Greenhouse-Geisser correction was applied to the mean absolute values of the differences in the error of estimation of the individual stimulus durations for the different postures, and statistically significant differences were found between the postures for 500-ms ($F(2.674,45.465) = 13.261$, $p < .001$, $\eta2 = .438$), for 1000ms ($F(2.989,50.808) = 5.963$, $p = .001$, $\eta2 = .260$), for 4000ms ($F(4,68) = 6.505$, $p = .001$, $\eta2 = .277$), and for 6000ms ($F(2.202,37.440) = 4.227$, $p = .019$, $\eta2 = .199$) but not for 3000ms ($p>0.05$) . The significant differences between the different postures for each stimulus duration, as revealed by post hoc analyses with Bonferroni correction, are also shown in Table 1. In figure 3 the differences between the estimated and actual durations of each stimulus are adjusted to 1000 milliseconds (twice the TPD mean for 500ms; the TPD mean for 1000ms; one-third the TPD mean for 3000ms; one-fourth the TPD mean for 4000ms; one-sixth the TPD mean for 6000ms) to compare how each time perception is subjectively distorted.

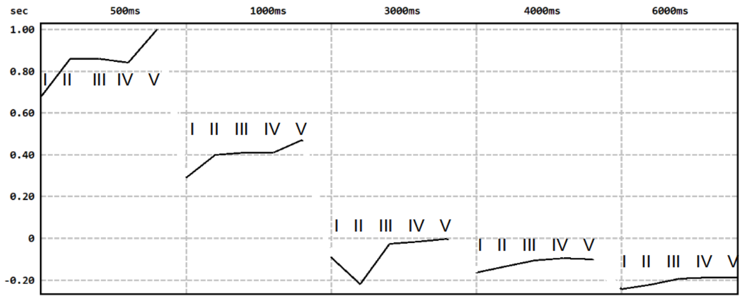

Figure 3. "Adjusted" (see text) mean absolute values of the differences in the error of estimation of the individual stimulus durations for the different postures ; I: Sit; II: Stand; III: Lying; IV: Lying HDT; V: Lying prone

Table 1. Time perception differences to objective durations for all postures

Time Perception Differences (TPD) to Objective Duration				Significant differences between postures	Significance level p
Objective Duration	Posture	TPD Mean (s)	TPD SD (s)		
500ms	Sit	0.34	0.06	Sit to Stand	0.006
	Stand	0.43	0.13	Sit to Lying HDT	0.044
	Lying	0.43	0.15	Sit to Lying prone	0.000
	Lying HDT	0.42	0.13	Stand to Lying prone	0.002
	Lying prone	0.5	0.14	Lying to Lying prone	0.001
				Lying HDT to Lying prone	0.025
1000ms	Sit	0.29	0.14		
	Stand	0.4	0.14	Sit to Stand	0.013
	Lying	0.41	0.22	Sit to Lying prone	0.002
	Lying HDT	0.41	0.18	Stand to Lying prone	0.002
	Lying prone	0.47	0.19		
3000ms	Sit	-0.28	0.31	No significant differences	p>0.05
	Stand	-0.66	0.47		
	Lying	-0.08	0.4		
	Lying HDT	-0.05	0.37		
	Lying prone	-0.01	0.36		
4000ms	Sit	-0.66	0.47		
	Stand	-0,54	0.5	Sit to Lying HDT	0.013
	Lying	-0.42	0.49	Stand to Lying HDT	0.01
	Lying HDT	-0.38	0.47		

	Lying prone	-0.4	0.52		
6000ms	Sit	-1.46	0.8		
	Stand	-1.33	0.92	Stand to Lying	0.002
	Lying	-1.16	0.9		
	Lying HDT	-1.12	0.88		
	Lying prone	-1.13	0.85		

SD: Standard deviation

DISCUSSION

To the best of our knowledge, this study is the first to compare time perception in these five different body postures, with particular attention to the head-down and prone postures. Consistent with the existing literature, we were able to show that the perception of time is significantly influenced by the different body postures. In contrast, the only common finding across all postures tested was that participants perceived shorter stimulus durations as longer, and vice versa, they perceived longer durations as shorter than the actual elapsed time, confirming Vierordt's Law (Brown, 1995).

Specifically, we found that the physically and mentally healthy participants perceived time more slowly when they adapted a lying posture (supine, prone, and -15 degrees HDT) without cognitive load. This result was consistently observed for all five stimulus durations (see figure 3), with certain lying postures showing statistically significant differences (see table 1). This result is in line with the few scientific studies that have examined the relationship between posture and time perception or cognitive function. In the only comparable study to examine the relationship between various postures and time perception, participants were asked to assume nine different postures (standing, leaning forward, leaning forward while sitting, twisting the trunk to both sides, bending the trunk, bending to the side, pushing, and pulling) and then to estimate the time that elapsed during the posture. Apart from the push and pull activities, there were no notable differences between the perceived durations and the actual durations (Kumar, 1993). As for cognitive functioning, Muehlhan and colleagues found that participants' performance on a working memory task was affected by their sleep quality when in the supine posture, but not while sitting. The heart rate variability parameters that were recorded indicated differences in autonomic regulation between the upright and supine positions (Muelhan et al., 2014). In the only, yet intriguing study that compared the prone and supine positions, participants were tasked with determining the moment an approaching object would make contact while lying supine or prone. The body position significantly impacted estimated time-to-contact, but only with extended occluded approach times (2.5-3s). In the prone position, time-to-contact estimates were longer (Baurès and Hecht, 2011). Although this study differs from ours in that it addresses time perception and body posture variables from the context of the visual stimulus, it supports the findings of our study by demonstrating the differential effect of prone and supine postures on time perception.

Interestingly, the differences between the subjective perception of time, which was adjusted to one second (see Methods section), and the objective stimulus duration in the present study were almost minimal at a stimulus duration of three seconds in the lying postures. This finding supports the argument that there is an "experienced moment" of about 3 seconds in duration, involving the automatic binding of events into perceptual units on this time scale, which has been demonstrated for the accuracy of reproducing stimulus durations (Pöppel, 2002).

RESULTS

The result of our study is that for the shortest stimulus duration (500ms), there were significant differences even between the lying body postures, with the prone posture causing a prolongation of time perception compared to the supine and HDT postures. The prone posture may lead to unfavorable physiological conditions in the brain as MRI measurements showed that the occipital CSF layer between the brain and skull changes by approximately 30% in thickness when a subject moves between supine and prone postures (Rice et al., 2013). Since our study found that participants reproduced longer subjective durations during HDT compared to sitting and standing, and related research has shown that a slight increase in intracranial pressure induced by HDT is associated with an increase in sympathetic nerve activity, a similar conclusion can be drawn for the HDT posture (Kermorgant et al., 2022). An essential consideration in this context is recent research indicating that the horizontal supine posture, both during rest and passive perceptual tasks, results in significant alterations in the neural networks typically activated in alert, seated individuals (Spironelli and Angrilli, 2017).

SUGGESTIONS

One limitation of our study is that the order in which postures were measured was not changed. This may have increased the likelihood of participants perceiving a longer time spent in the reclining position due to higher levels of fatigue. Another noticeable shortcoming is that the measurements were not carried out with the registration of physiological parameters (e.g. heart rate variability). This shortcoming meant that a complete physiological comparison between the time perceptions in different body postures was not possible, particularly for autonomic arousal. Nonetheless, our study is the initial one to demonstrate the influence of these postures (sitting, standing, and the three different lying postures) on time perception.

Information on Ethics Committee Permission
Ethics committee: Marmara University Faculty of Medicine, Clinical Research Ethics Committee
Division / Protocol No: 09.2020.254

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CITING

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