

Variation in cognitive investment: making time fly... or drag!

Variação no investimento cognitivo: fazendo o tempo voar... ou se arrastar!

Variación en la inversión cognitiva: hacer que el tiempo vuele... ¿o se arrastre!

DOI:10.34119/bjhrv7n2-391

Originals received: 03/15/2024

Acceptance for publication: 04/01/2024

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ABSTRACT

Social media is increasingly prevalent in the daily lives of young people as a source of entertainment and social interaction. However, the time spent on such stimuli reduces availability for other activities that used to be more prevalent, such as reading, development of motor skills, and face-to-face social interaction. Little is known about the effects of this habit changes on the cognitive development of young individuals. One possible way to assess cognitive investment in a particular task is through the perception of time passage. In the present study, we investigated the cognitive investment in different activities and its relationship with the perception of time passage in young individuals aged 14 to 15 years old. Four groups of volunteers were formed. Each group performed a different activity for 23 minutes. Group 1 spent the 23 minutes browsing a social network (TikTok); Group 2 read classics of Brazilian literature; Group 3 played the board game “Pictionary”; and Group 4 was instructed to practice a complex pen spinning around the fingers. The duration of the activity was not disclosed, and at the end of the 23 minutes, volunteers were individually asked how much time they thought had passed during the activity. The group that engaged in TikTok had an average perception of 20 minutes, a value almost identical to the pen spinning, which was 19 minutes, with no statistically significant difference between them ($p > 0.05$). On the other hand, activities requiring greater cognitive effort and social interaction, such as reading and the board game, had average time perceptions of 25 and 28 minutes, respectively. The latter two even reached time perception values of 40 and 44 minutes, which were the highest in the entire experiment. According to analysis of variance, groups with the lowest mean time perception (TikTok and pen spinning) were significantly different from the board game group ($p < 0.05$). Based on our results, we can conclude that the nature of the activity undertaken affects time perception on the brain. This may be related to the amount of new information presented and absorbed during novelty and learning activities. Engaging in new and cognitive demanding experiences give the impression that time lasted longer. Conversely, repetitive activities without new stimuli give

the sensation that the same time interval seems shorter. Further studies investigating the consequences of overexposure to repetitive and unstimulating activities are necessary to understand their potential effects on the brain development of adolescents.

Keywords: social media, TikTok, reading, cognition, neuroplasticity.

RESUMO

A mídia social está cada vez mais presente no cotidiano dos jovens como fonte de entretenimento e interação social. No entanto, o tempo gasto com esses estímulos reduz a disponibilidade para outras atividades que costumavam ser mais predominantes, como a leitura, o desenvolvimento de habilidades motoras e a interação social face a face. Pouco se sabe sobre os efeitos dessas mudanças de hábito no desenvolvimento cognitivo de indivíduos jovens. Uma maneira possível de avaliar o investimento cognitivo em uma determinada tarefa é por meio da percepção da passagem do tempo. No presente estudo, investigamos o investimento cognitivo em diferentes atividades e sua relação com a percepção da passagem do tempo em jovens de 14 a 15 anos de idade. Foram formados quatro grupos de voluntários. Cada grupo realizou uma atividade diferente durante 23 minutos. O Grupo 1 passou os 23 minutos navegando em uma rede social (TikTok); o Grupo 2 leu clássicos da literatura brasileira; o Grupo 3 jogou o jogo de tabuleiro "Pictionary"; e o Grupo 4 foi instruído a praticar um complexo giro de caneta em torno dos dedos. A duração da atividade não foi divulgada e, ao final dos 23 minutos, os voluntários foram questionados individualmente sobre quanto tempo achavam que havia se passado durante a atividade. O grupo que participou do TikTok teve uma percepção média de 20 minutos, um valor quase idêntico ao do giro da caneta, que foi de 19 minutos, sem diferença estatisticamente significativa entre eles ($p > 0,05$). Por outro lado, as atividades que exigem maior esforço cognitivo e interação social, como a leitura e o jogo de tabuleiro, tiveram percepções médias de tempo de 25 e 28 minutos, respectivamente. As duas últimas chegaram a atingir valores de percepção de tempo de 40 e 44 minutos, que foram os mais altos de todo o experimento. De acordo com a análise de variância, os grupos com a menor média de percepção de tempo (TikTok e girar caneta) foram significativamente diferentes do grupo do jogo de tabuleiro ($p < 0,05$). Com base em nossos resultados, podemos concluir que a natureza da atividade realizada afeta a percepção do tempo no cérebro. Isso pode estar relacionado à quantidade de novas informações apresentadas e absorvidas durante as atividades de novidade e aprendizado. O envolvimento em experiências novas e cognitivamente exigentes dá a impressão de que o tempo durou mais. Por outro lado, atividades repetitivas sem novos estímulos dão a sensação de que o mesmo intervalo de tempo parece mais curto. São necessários mais estudos que investiguem as consequências da superexposição a atividades repetitivas e não estimulantes para entender seus possíveis efeitos sobre o desenvolvimento do cérebro dos adolescentes.

Palavras-chave: mídia social, TikTok, leitura, cognição, neuroplasticidade.

RESUMEN

Los medios sociales están cada vez más presentes en la vida cotidiana de los jóvenes como fuente de entretenimiento e interacción social. Sin embargo, el tiempo dedicado a estos estímulos reduce la disponibilidad para otras actividades que solían ser más frecuentes, como la lectura, el desarrollo de habilidades motoras y la interacción social cara a cara. Poco se sabe sobre los efectos de estos cambios de hábitos en el desarrollo cognitivo de los individuos jóvenes. Una posible forma de evaluar la inversión cognitiva en una tarea determinada es a través de la percepción del paso del tiempo. En el presente estudio, investigamos la inversión cognitiva en diferentes actividades y su relación con la percepción del paso del tiempo en jóvenes de 14 a 15 años. Se formaron cuatro grupos de voluntarios. Cada grupo realizó una

actividad diferente durante 23 minutos. El Grupo 1 pasó los 23 minutos navegando por una red social (TikTok); el Grupo 2 leyó clásicos de la literatura brasileña; el Grupo 3 jugó al juego de mesa "Pictionary"; y al Grupo 4 se le indicó que practicara un complejo giro de bolígrafo alrededor de los dedos. No se reveló la duración de la actividad y, al final de los 23 minutos, se preguntó a los voluntarios individualmente cuánto tiempo creían que había transcurrido durante la actividad. El grupo que participó en TikTok tuvo una percepción media de 20 minutos, un valor casi idéntico al del giro del bolígrafo, que fue de 19 minutos, sin diferencias estadísticamente significativas entre ellos ($p > 0,05$). Por otro lado, las actividades que requieren mayor esfuerzo cognitivo e interacción social, como leer y jugar a juegos de mesa, tuvieron percepciones medias de tiempo de 25 y 28 minutos respectivamente. Estas dos últimas alcanzaron incluso valores de percepción del tiempo de 40 y 44 minutos, que fueron los más altos de todo el experimento. Según el análisis de la varianza, los grupos con las percepciones medias de tiempo más bajas (TikTok e hilar bolígrafos) fueron significativamente diferentes del grupo de juegos de mesa ($p < 0,05$). Basándonos en nuestros resultados, podemos concluir que la naturaleza de la actividad realizada afecta a la percepción del tiempo en el cerebro. Esto puede estar relacionado con la cantidad de información nueva presentada y absorbida durante las actividades novedosas y de aprendizaje. Participar en experiencias nuevas y cognitivamente exigentes da la impresión de que el tiempo ha durado más. Por otro lado, las actividades repetitivas sin estímulos nuevos dan la sensación de que el mismo intervalo de tiempo parece más corto. Se necesitan más estudios que investiguen las consecuencias de la sobreexposición a actividades repetitivas y no estimulantes para comprender sus posibles efectos en el desarrollo cerebral de los adolescentes.

Palabras clave: redes sociales, TikTok, lectura, cognición, neuroplasticidad.

1 INTRODUCTION

Generation Z is the term coined for young individuals born in the post-internet era, who have never experienced a world without this new tool (Dolot, 2018), which facilitates communication between physically distant individuals and the dissemination of information and new content, but is predominantly utilized passively, primarily on social media platforms (PrakashYadav and Rai, 2017). However, the time dedicated to this type of stimulus reduces availability for other activities that used to be more prevalent, such as reading, writing, sports activities, learning musical instruments, and other forms of in-person distraction and entertainment. Such activities play an important role in the development of motor, social, and cognitive skills (Geertsen et al., 2016), which are essential throughout life, but are being replaced for virtual activities (Turner, 2015).

Social media applications exploit hormonal metabolic pathways, such as dopamine, to engage users (Jargon, 2022). They provide quick rewards with low demand for cognitive effort required to receive them. It uses the Variable Ratio Reinforcement system, which is the same system used in slot machines, with high addictive potential, especially in young, developing

minds (Flayelle et al., 2023). Social media addiction is a psychosocial problem. Projected consequences of this addiction include anxiety disorders, depression, Fear of Missing Out (FOMO), lack of concentration (Keles et al., 2020), and difficulty dealing with delayed gratification stimulus (Du et al., 2019), which is crucial for brain development and is a predictive of professional success, as demonstrated in the famous marshmallow experiment (Mischel and Ebbesen, 1970; Buczny, 2020).

However, much effort still needs to be made for a better understanding of the real effects that this change in habits may have on the cognitive development of young individuals and how it may affect coping with life challenges.

One way to test cognitive investment in a particular task is through the perception of the passage of time (Matthews and Mack, 2016). Some studies have addressed the perception of the passage of time, either through direct questions such as "How fast did you feel time passed in the last three days?" (Loose et al., 2022; Wessels et al., 2022), or through very short experiments lasting less than a minute (Baugh and Mason, 1986; Livesey et al., 2007).

In the present study, we investigate the hypothesis that activities requiring active attention, which demand greater cognitive effort, tend to give the sensation that more time has passed during a certain interval, while repetitive activities of passive attention, requiring less cognitive effort, such as the use of social media, tend to give the sensation that less time has passed in that same interval.

2 METHODS

Four groups of volunteers were formed with students aged between 14 and 15 years old. Each group was guided to perform a different activity for 23 minutes, but none of the groups were informed of the duration of the activity.

Group 1 consisted of 22 volunteers, the only group allowed access to cellphones during the activity. They were instructed to use the TikTok application for the duration of the experiment

Group 2 comprised 22 volunteers who spent the 23 minutes without cellphones. They were instructed to spend the time reading from Brazilian classic literature. Books were pre-selected from the school library.

Group 3 consisted of 26 volunteers who spent the same time interval playing the collective board game titled "Imagem e Ação" (Pictionary).

Similarly, Group 4, comprised 26 volunteers, watched the YouTube video tutorial titled "SPIN A PEN Around Your Thumb in 2 EASY Steps" available at the link: <https://www.youtube.com/shorts/eZ18wqZUxTc>, prior to the experiment, and were subsequently instructed to spend the time trying to learn the complex movement of spinning a pen around the thumb.

The four experiments were conducted simultaneously in different and distant rooms to avoid interference.

After the 23 minutes of activity, all volunteers were instructed to wait outside the room where the experiment was conducted, and one by one they were called to enter. Volunteers from Group 1 were asked two questions:

1. Did you check the cellphone clock during the activity?
2. How long do you think has passed during the activity?

After answering the questions, the volunteer waited inside the room until all other volunteers had been called. If the answer to the first question was positive, the volunteer's response was disregarded.

Volunteers from the other groups were asked only the second question since they did not have cellphones during the activity.

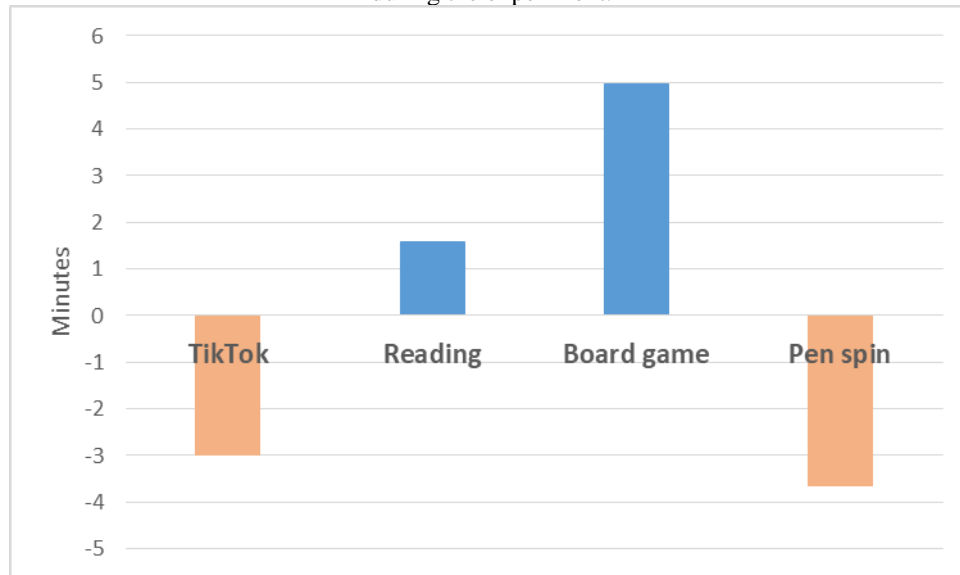
Following the registration of responses, a Shapiro-Wilk test was performed to assess the normality of the data using Jamovi software. The results were then computed in a spreadsheet and used for non-parametric statistical analysis of variance (PERMANOVA) through globally and pairwise tests based on Euclidean distance calculation using Primer 6 software. We also conducted descriptive statistical analyses in Jamovi to construct boxplot graphs to visually represent the patterns found.

3 RESULTS

Group 1, consisting of volunteers who used TikTok during the experiment, had a perception of time passage ranging from 10 to 35 minutes, with a mean of 20 minutes out of the 23 that actually elapsed. Among the 22 volunteers in this group, three had their responses disregarded due to their affirmative answer to the first question in the questionnaire, indicating that they checked the cellphone clock during the activity. Group 2, which engaged in reading activity, perceived time ranging from 5 to 40 minutes, with a mean of 25 minutes. Group 3, involved in the group board game, perceived time ranging from 17 to 44 minutes, with an average perception of 28 minutes. Finally, Group 4, attempting pen spinning around the thumb,

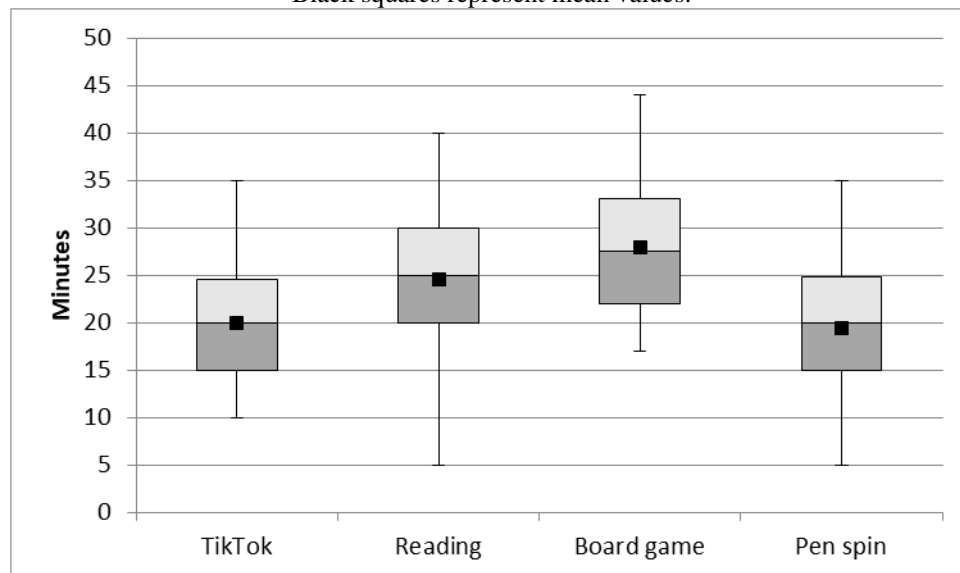
had time estimates ranging from 5 to 35 minutes, with a mean of 19 minutes (Figure 1 and Figure 2). According to Shapiro-Wilk analysis, none of the groups' responses exhibited normal distribution, indicative for non-parametric variance analysis using PERMANOVA.

Figure 1 – Mean difference in time perception relative to the actual 23 minutes of the activities among volunteers during the experiment.



Source: Rocha et al., 2024

Figure 2 - Boxplot showing maximum and minimum values, as well as quartile values and the median, regarding the perception of time among the volunteers involved in each of the activities performed during the experiment. Black squares represent mean values.



Source: Rocha et al., 2024

Regarding the analysis of variance (PERMANOVA), it was demonstrated that there is a significant global difference in the perception of time passage among the volunteers in the experiment regarding the activities analyzed ($p = 0.001$). Pair-wise analysis indicated that the

differences were mainly in the comparison between Group 1 (TikTok) and Group 3 (board game) ($p = 0.001$), between Group 2 (reading) and Group 4 (pen spinning) ($p = 0.039$), and between Group 3 (board game) and Group 4 (pen spinning) ($p = 0.001$) (Table 1).

Table 1 - Significance values of the volunteers responses between each group in pair-wise and global tests, considering all groups. Gray and bold values represent statistically significant differences.

Groups	<i>p</i> Value
Pair-wise test	
TikTok / Reading	0.112
TikTok / Board game	0.001
TikTok / Pen spin	0.659
Reading / Board game	0.136
Reading / Pen spin	0.039
Board game / Pen spin	0.001
Global test	0.001

Source: Rocha et al., 2024

4 DISCUSSION

The perception of time is indeed variable, leading to the common saying that "time is relative," without necessarily referring to Einstein's concepts. Studies have been conducted on this topic, concluding that the mental perception of the passage of time is related to cognitive processes (Baugh and Mason, 1986; Livesey et al., 2007). However, those studies in time perception were conducted during short time intervals, with only a few seconds for each activity.

In the present study, we were able to demonstrate the same relationship between time perception and the cognitive demand of a specific activity in an experiment with activities with a longer elapsed time.

Age is a factor that also seems to interfere with time perception (Zélanti et al., 2011), but we avoided the influence of this variable on our results as all selected volunteers were between 14 and 15 years old, allowing for the interpretation of results without this methodological interference.

Among the activities analyzed, the board game activity showed the greatest mean distortion in relation to the elapsed time, with volunteers perceiving an average of 28 minutes, five minutes longer than the actual time elapsed, representing a 22% error. The board game is an activity that requires a lot of attention, focus, and cognitive effort, interfering with the perception of time passage in a manner similar to what has been demonstrated in studies with shorter activity durations. Furthermore, board games stimulate significant social engagement,

which may also influence volunteers' perception of time passage (Loose et al., 2022; Wessels et al., 2022).

The reading activity showed the highest diversity of responses among volunteers' perception, with a minimum of five minutes and a maximum of 40 minutes, with the biggest standard error (Figure 2). Time distortion between volunteers that read during the activity reached up to 21 minutes, representing a 91% error. Reading is an activity that demands significant cognitive effort and attention (Britton et al., 1982). In 1975, Thomas and Weaver, in a study on visual stimuli and letter memorization, concluded that the higher the cognitive demand of a particular activity, the greater the sensation of duration of that activity. This same pattern was found in an experiment on activities with different cognitive demands in short-term experiments (Kahn et al., 2006). Therefore, the wide variation in responses obtained in our study may indicate different levels of engagement of volunteers with the activity, with some engaging in deep and focused reading while others engage in superficial and inattentive reading.

According to statistical analysis, attempting pen spinning and using the TikTok application were activities that provided the sensation of less time passage, both with significantly different results from the board game activity. Attempting pen spinning is extremely complex to master in the few minutes of activity, and it was observed during the experiment that the frustration of young volunteers with the task difficulty led them to lose interest and consequently focus on the activity, reducing cognitive demand and attention.

Finally, the use of social media (TikTok) showed statistically similar results when compared to the activity with the lowest engagement level among volunteers, which was pen spinning. Social media use was performed with visible engagement, despite not significantly increasing quantitatively the perception of time spent. This indicates that even when performed with focus, social media use does not require significant cognitive demand. The nature of social media activity is linked to short and repetitive stimuli, providing the user with more of the same content they have already shown interest in and are familiar with. This lack of cognitive investment, even when performed with focus, may be the cause of the relative short time passage perception among volunteers.

The human brain has neuroplasticity, being capable of molding itself through stimulating activities (Bassett et al., 2011; Li et al., 2014). That is directly related to learning and cognitive development, which is especially important in a young, developing brain (Ekman et al., 2022). Our results reinforce the recurring concern about the physiological effects of excessive social media stimulation at this stage of life, as the impacts arising from this practice are not yet fully understood.

In a fast-paced world that gives the feeling that everything passes too quickly, it is important to invest time in activities that require greater focus and full attention. Our results indicate that it is possibly the way for richer and fuller life experiences. Since activities with low cognitive demand, such as social media use, are being used more than those with higher cognitive demand, such as reading and board games, is justified the concern about the formation of a generation with lower learning capacity and memory retention. It is possible to infer that for a healthier brain, it is important to have it regularly stimulated by activities that generate learning and novelty. The relationship between repetitive, banal, and regular stimulus and psychological risks such as anxiety and depression is being better understood (Keles et al., 2020), but further studies are needed to understand how this affects the learning capacity of young individuals.

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