OPEN ACCESS

ESCOLA DE CIÊNCIAS DA SAÚDE E DA VIDA

PSICO

Psico, Porto Alegre, v. 55, n. 1, p. 1-12, jan.-dez. 2024
e-ISSN: 1980-8623 | ISSN-L: 0103-5371

http://dx.doi.org/10.15448/1980-8623.2024.1.42132

SEÇÃO: ARTIGOS

Dynamic Visual Noise Disrupts Mental Image Task Based On The Retro-cue Paradigm

Ruído visual dinâmico afeta a tarefa de imagem mental com base no paradigma de retro-dica

El ruido visual dinámico afecta la tarea de imagen mental basada en el paradigma retro-cue

Mariana Ribeiro Maniglia[1]
orcid.org/0000-0003-4353-2341
marianamaniglia@alumni.usp.br

César Alexis Galera[2]
orcid.org/0000-0002-3021-7126
algalera@usp.br

Recebido em: 20 nov. 2021.
Aprovado em: 28 dez. 2022.
Publicado em: 21 out. 2024.

Abstract: The retro-cue effect (RCE) is known in memory tasks to produce an increase in accuracy and decrease in response time. The retro-cue brings the information to the focus of attention in an active state, but it is not known whether it is retrieved as a conscious mental image. In this study, we investigated whether the retro-cue brings the cued item to an active state, allowing its phenomenological consciousness. In each trial, the participants rated the vividness of the retro-cued item and then recognized it. Perceptual visual interference was used to certify the visual nature of the retrieved items. Our results showed a significant RCE in memory recognition, but not in the vividness rating. The mental image vividness and the recognition tasks are based on different cognitive processes and are subject to different interferences, but despite the different cognitive processes, there is a correlation between them.

Keywords: mental image, working memory, attention, consciousness

Resumo: O efeito da retro-dica é conhecido em tarefas de memória por produzir um aumento na precisão e uma diminuição no tempo de resposta. A retro-dica traz a informação para o foco de atenção em um estado ativo, mas não se sabe se ela é recuperada como uma imagem mental consciente. Neste estudo, investigamos se a retro-dica recupera o item indicado para um estado ativo, permitindo sua consciência fenomenológica. Em cada prova, os participantes avaliaram a vivacidade do item indicado pela retro-dica e, em seguida, o reconheceram. A interferência visual perceptual foi usada para certificar a natureza visual dos itens recuperados. Nossos resultados mostraram um efeito significativo da retro-dica no reconhecimento da memória, mas não no julgamento da vivacidade. A vivacidade da imagem mental e as tarefas de reconhecimento são baseadas em diferentes processos cognitivos e estão sujeitas a diferentes interferências. Apesar dos diferentes processos cognitivos, existe uma correlação entre eles.

Palavras-chave: memória operacional, atenção, imagem mental, consciência

Abstracto: El efecto retro-cue (RCE) es conocido en las tareas de memoria por producir un aumento en la precisión y una disminución en el tiempo de respuesta. La retro-señal trae la información al foco de atención en un estado activo, pero no se sabe si se recupera como una imagen mental consciente. En este estudio, investigamos si la retro-señal lleva al elemento señalado a un estado activo, permitiendo su conciencia fenomenológica. En cada ensayo, los participantes calificaron la intensidad del elemento retro-indicado y luego lo reconocieron. Se utilizó la interferencia visual perceptiva para certificar la naturaleza visual de los elementos recuperados. Nuestros resultados mostraron un RCE significativo en el reconocimiento de la memoria, pero no en el índice de viveza. La viveza de la imagen mental y las tareas de reconocimiento se basan en diferentes procesos cognitivos y están sujetas a diferentes interferencias, pero a pesar de los diferentes

[1] Universidade de Ribeirão Preto (UNAERP), Ribeirão Preto, SP, Brasil.
[2] Universidade de São Paulo (USP), Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Ribeirão Preto, SP Brasil.

procesos cognitivos, existe una correlación entre ellos.
Palabras-clave: memoria de trabajo, atención, imagen mental, conciencia

Every day we are flooded with visual information, and voluntarily or involuntarily our brain generates mental images (MI) to remember situations, people or solve problems. Try to remember the SpongeBob square pants character. How many teeth does he have? Is he wearing a hat? What color is his tie? You have probably generated a visual mental image of the character and inspected the requested traits. This phenomenon is experienced through the mind's eyes (Nanay, 2018; J. Pearson, 2019; Thompson, 2007). The ability to generate a mental image without visual perceptual input is a complex cognitive process and difficult to investigate due to its phenomenological character, that is, subjective and unique (El Haj et al., 2019; Kosslyn et al., 2001). This study proposed to investigate the mental image generation process through the retro-cue paradigm.

The retro-cue allows us to direct our attention through an internal representation that likely could involve a mental image of the remembered array (Griffin & Nobre, 2003). In the retro-cue paradigm, the participant memorizes a visual scene with some stimuli distributed in space. In the end of the retention interval, when these stimuli are no longer available to perception, the participant is informed by a spatial retro-cue about the location of the stimulus that has the highest probability of being presented as the probe test. When the retro-cue is informative, that is, when the retro-cued item is indeed presented as the probe test, we observe a gain in speed and accuracy (Lepsien & Nobre, 2006; Souza & Oberauer, 2016). The Retro-cue effect (RCE) is widely known in scientific literature for providing increased accuracy and decreased response time in working memory tasks (Li et al., 2021; Niklaus et al., 2019; Zerr et al., 2021).

Jacob, Jacobs and Silvanto (2015) suggests that the retro-cue may retrieve the cued item to an attended state under the Focus of Attention (FoA), but to bring the cued item to a phenomenological state of consciousness as a mental image, it is necessary to manipulate or inspect the stimulus. The working memory (WM) model proposed by Baddeley (Baddeley, 2007) establishes that the WM content is conscious. However, the dissociation between attended and conscious state could be explained through studies showing that items could be attended even in the absence of awareness (Hassin et al., 2009; Soto et al., 2011). In contrast, studies also argued the MI generation without consciousness, such as flashbacks of an unpleasant scene (Nanay, 2021).

Attention would play an important role in bringing the content into consciousness. Jacob, Jacobs and Silvanto (2015) proposed three different levels between the relation of attended and the conscious state associated with the top-down control, (a) a non-conscious and unattended level, (b) non-conscious and attended level, that involves the Focus of Attention (FoA), and (c) phenomenological conscious attended level, that involves a top-down process and a mental representation.

Until now there is no consensus about the nature and the phenomenological status of the retrieved information in the retro-cue paradigm, whether it involves a mental image of the cued item or not. According to Jacobs and Silvanto (2015) the information under the FoA, can give rise to a phenomenological conscious experience if it is inspected and/or manipulated as a mental image. The retro-cue paradigm brings the memorized information to the FoA, but the question is whether the information is available as a conscious mental image. There are several possible ways to answer this question. One is to ask the participant to manipulate the retrieved cued item or to rate the vividness of the mental image generated from the retro-cue (Jacob et al., 2015). A second way is to verify whether the information generated from the retro-cue is sensitive to an irrelevant visual information, for example, the Dynamic Visual Noise (DVN) (McConnell & Quinn, 2000; Quinn & McConnell, 2006; Valenti & Galera, 2020). Finally, although this is not a pacified issue in literature, another way to assess whether the information is available as a mental image is to correlate the mental image's vivacity with memory performance (Bona et al., 2013).

A conscious mental image can be created from the inspection and/or manipulation of a memorized item/scene. The inspection can be verified through the mental image vividness rating (Dijkstra et al., 2017, 2019; Runge et al., 2017; Wilson et al., 2018), for example, by the Vividness of Visual Imagery Questionnaire (VVIQ) (Marks, 1973). On the other hand, the manipulation involves the metacognitive ability to change the mental image perspective and can be verified by asking the participant to rotate a stimulus without the perceptual input (Pearson et al., 2011). The inspection of the mental image through the vividness assessment involves a subjective and individual gradient of detail and clarity of the mental image experience and has been often used through tasks based on VVIQ (Baddeley & Andrade, 2000; Cui et al., 2007; Keogh & Pearson, 2018). This questionnaire is composed of statements that refer to everyday images that participant must imagine and then evaluate its vividness according to a five-point rating scale that ranges from "Perfectly clear and vivid as a real view" (rating 5) to "No image formed, I just know that I am thinking about the object" (rating 1). That is, the more vivid a mental image, the closer it is to a perceptual stimulus.

The mental image seems to be vulnerable to perceptual interference, such as DVN. Besides that, the DVN effect happens while mental images are being generated or while they are being recovered, in other words, the DVN effect happens when the mental image is under consciousness (McConnell & Quinn, 2000; Quinn & McConnell, 2006). The DVN disturbs the visuospatial sketch competing for storage capacity or recitation process, and reduces the vividness with which the mental image is perceived (Baddeley & Andrade, 2000). It's possible to suppose that the perceptual visual input compete with the generation of the mental image. In order to experience a mental image we need to inhibit this perceptual visual input to prevent its access to consciousness. This top-down inhibition is a strong factor that contributes with a conscious experience of a mental image but, under normal circumstances, a strong perceptual stimulus is likely to win the competition for consciousness (Jacob et al., 2015).

The correlation between the vividness rating of mental image and the memory performance is controversial. Some studies have shown that participants with stronger mental images tend to rely more on mental images to perform the memory task than individuals with weak mental images (Cui et al., 2007; Keogh & Pearson, 2014). Other studies suggest a dissociation between the subjective (conscious) and objective aspects of our memory (Bona et al., 2013; Bona & Silvanto, 2014). Studies with patients with Aphantasia, an inability to generate mental images, showed that although the MI performance was compared to the control group, the WM performance was worse than control group (Jacobs et al., 2018). Scientific literature shows that these two processes could active the same cortical areas, together with perceptual areas, but the relation between these cognitive functions is not clear, as well as the implication of consciousness (Albers et al., 2013; Gayet et al., 2017; Huang et al., 2021; Kosslyn et al., 2001).

In this study, we investigated whether orienting attention through the retro-cue to an internal visual representation brings it to an active state, allowing its phenomenological consciousness. There are several ways to infer whether the retro-cue is associated with the mental image generation that can be consciously inspected. We investigated whether the representation generated by the retro-cue is sensitive to perceptual visual interference (DVN) and whether this representation can be evaluated through vividness rating as a phenomenological mental image experience. We also investigated the correlation between the mental image vividness rating and the memory performance in a recognition task. If the retro-cue representation would be retrieved as a mental image then we expected the perceptual visual interference (DVN) disturbed the vividness rating in informative retro-cue. We also expected the vividness rating in informative retro-cue condition better than in neutral retro-cue condition.

Method

Participants

There were 16 participants (10 women; M = 23 years; range=18 to 35 years) in this experiment, all students from the University of São Paulo. The subjects participated voluntarily and all participants had normal or corrected to normal vision. The participants signed an informed consent at the beginning of the experiment. The study protocol is in line with the ethical guidelines of the University of São Paulo (CAAE: 26835614.3.000.5407).

Material and stimuli

The experiment was programmed using E-Prime software (Schneider et al., 2002). The stimuli were the uppercase letters "D - H - Q – R", with different graphics fonts. Ten different graphics fonts were used: "Ravie", "Speculum", "Pixel LCD7", "Street Cred", "Dotcirful", "Alien Encounters", "Army Rust", "Chocolate Bar Demo", "Linowhite" and "Mexican Knappett" (https://www.dafont.com/pt). The fixation point was a triangular frame presented in the center of the screen.

The Dynamic Visual Noise (DVN) is an irrelevant visual information presented in the center of a monitor's screen composed by a drizzle of white and black squares randomly displayed. The DVN was formed by a matrix of 80 x 80 points, each point with 4 x 4 pixels, half of the points were white and half were black. It covered an area of approximately 13.5 x 13.5 cm in the center of the screen.

Procedure

The task consisted of memorizing 3 stimuli followed by the retention interval, afterward, a retro-cue was presented (could be informative or neutral), the participant should recover the representation showed by the retro-cue. After, the participant made the vividness rating about the retro-cued item (in the DVN presence or blank screen) and finally performed the recognition of the test item.

At the beginning of each trial, the fixation point was presented for 500 milliseconds (ms). The memory array consisted in three stimuli (for example, the letter R presented in 'Ravie', 'Speculum' and 'ArmyRust' graphical fonts) presented for 3 seconds followed by a 2 seconds of retention interval. Then the retro-cue (250 ms) was presented. The retro-cue was valid informative (50%) or neutral (50%). After the retro-cue presentation, the participant was requested by a beep, presented for 50 ms, to rate the vividness of the cued item, in case of an informative retro-cue, or of the three memorized stimuli, in the case of a neutral retro-cue. The DVN was presented during the vividness rating 50% of trials; in the remaining trials, the screen was blank. The vividness rating was made on the numeric keyboard accord the following scale: "1- I do not remember"; "2- I remember, but I can not imagine"; "3- I have a vague image"; "4- I have a moderately clear image"; "5- I have a clear and vivid image, like a real image". The vividness rating lasted 3.5 seconds. After the vividness rating, the recognition probe test was presented, and remained on the screen until participants decided whether it matched the cued memorized item by pressing the left mouse button for a match response or the right mouse button for a mismatch response. The probe test was equal to one of the memorized stimuli in 50% of the trials and not one of the memorized stimuli in the remaining trials (see Fig. 1). There were 96 trials, preceded by training with eight trials.

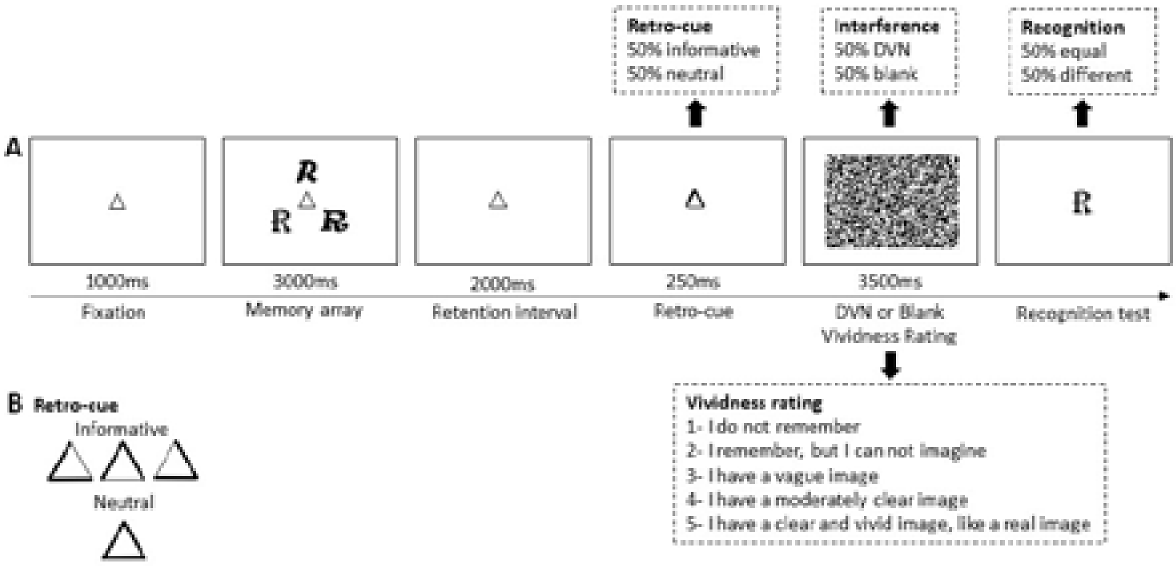

Figure 1. Example of the experimental trial. The participant memorized 3 stimuli (with the same letter but different graphic fonts) followed by the retention interval. After, a retro-cue (could be informative or neutral) was presented showing the location of the item that will be rating, the participant made the vividness rating about the retro-cued

Data Analysis

The memory recognition accuracy was transformed into a discrimination index (d') to verify the decision criterion for the response (Snodgrass & Corwin, 1988). The discrimination index (d') is computed by the difference between the hits and false alarms Z scores (d'= $Z_{hit} - Z_{false\ alarm}$). The Analyses of variance (ANOVA) was conducted in recognition d' considering the retro-cue condition (informative and neutral) and the interference condition (DVN and blank screen). The Response Time (RT) analysis considered only correct responses and RT ranges between 300ms and 3000ms. The analysis of vividness rating considered only the correct responses in memory recognition. The mean of RT (recognition and vividness rating) and the vividness rating were submitted to separate ANOVA's considering, for each analysis, the retro-cue condition (informative and neutral) and the interference condition (DVN and blank screen). Pearson's correlation was calculated between the mean of vividness RT vs. Vividness rating and the Accuracy vs. Vividness rating. Bonferroni test was applied to post hoc comparison, when necessary.

Results

Recognition

The d' analyses in memory recognition showed that the performance was not affected by the DVN [$F(1,15)=0.91$; $p=0.35$; $\eta^2_p=0.05$]. There was a retro-cue effect [$F(1,15)=28.16$; $p<0.001$; $\eta^2_p=0.65$], showing better performance in informative retro-cue (M=2.40, SEM=0.13) than in neutral retro--cue (M=1.69, SEM=0.12) (Fig.2.A). The RT analysis also did not show a DVN effect [$F(1,15)=1.00$; $p=0.33$;$\eta^2_p=0.06$], but it was effected by the retro-cue [$F(1,15)=49.66$; $p<0.01$; $\eta^2_p=0.76$]. The RT was faster (M=993ms, SEM=47ms) in informative retro-cue trial than the neutral retro-cue trials (M=1218ms, SEM=44ms) (Fig. 2.B) There was no interaction between the irrelevant visual information (DVN) and the retro-cue [$F(1,15)=0.19$; $p=0.66$; $\eta^2_p=0.01$].

Vividness rating

The vividness rating was not affected by the retro-cue [$F(1,15)=2.38$; $p=0.14$; $\eta^2_p=0.13$], but it was affected by the DVN [$F(1,15)=4.43$; $p=0.05$;

η^2_p=0.22]. The vividness rating was lower in DVN trials (M=3.93, SEM=0.12) than in blank screen trials (M=4.06, SEM=0.11). The Bonferroni post hoc test confirmed the significant visual interference effect of DVN (p=0.005). The response time to the vividness rating was not affected by the retro-cue (M_{info}=1125ms, M_{neu}=1062ms, p=.22) nor by the DVN presence (M_{DVN}=1105ms, M_{blank}=1082ms, p =.56).

Correlation

Vividness time vs. Vividness rating. The response time required to the vividness rating was inversely proportional to the vividness rating response (Fig.2.C). The participants rated the most vivid item faster and took longer to rate the low vivid item, as is showed in Table 1. The correlation of the general average between the RT and the vividness rating was r = -0.98 (p < 0.01).

Recognition accuracy vs. Vividness rating. The vividness rating and the recognition accuracy presented positive correlation. The more vivid, the greater the recognition accuracy (Fig. 2.D). The negative correlation showed in Table 2 in DVN/Informative condition can be explained by the result in category "1 - I do not remember" in which participants had answered that they did not remember the stimulus but correctly recognized 100% of the responses regarding this category. As the frequency rate response of the vividness rating '1' was low (Fig. 2.E), we analyzed the data removing response "1" from the total of this condition and the correlation coefficient is r = 0.83, indicating that the vividness rating "1" was responsible for the negative correlation presented. The correlation of the general average between the recognition accuracy and the vividness rating is r = 0.97 (p < 0.05), that is a high correlation between the factors.

Table 1 – Correlation between the mean of Vividness rating time and vividness rating

Vividness Rating	DVN		Blank		General average
	Informative M (SEM)	Neutral M (SEM)	Informative M (SEM)	Neutral M (SEM)	M (SEM)
1	1779(412)	2043 (713)	1662 (710)	1267 (728)	1687(161)
2	1258(263)	1841 (423)	1651 (383)	1674(376)	1606(123)
3	1400 (212)	1162 (180)	1347(190)	1187 (198)	1274(58)
4	1261 (193)	1136 (189)	1245 (189)	1101(163)	1186(39)
5	961(144)	672 (114)	1004 (147)	900(140)	885(73)
r	-0,86	-0,97	-0,97	-0,72	-0,98

Table 2 – Correlation between the mean recognition accuracy and vividness rating

Vividness Rating	DVN		Blank		General average
	Informative M (SEM)	Neutral M (SEM)	Informative M (SEM)	Neutral M (SEM)	M (SEM)
1	1 (0)	0,33 (0,33)	0,56 (0,23)	0,50 (0,28)	0,59 (0,14)
2	0,84 (0,06)	0,52 (0,11)	0,69 (0,16)	0,86 (0,07)	0,72 (0,07)
3	0,81 (0,06)	0,80 (0,04)	0,85 (0,05)	0,73 (0,04)	0,79 (0,02)
4	0,88 (0,04)	0,84 (0,07)	0,92 (0,04)	0,76 (0,04)	0,85 (0,03)
5	0,92 (0,03)	0,77 (0,09)	0,97 (0,01)	0,90 (0,02)	0,89 (0,04)
r	-0,25	0,86	0,97	0,70	0,97

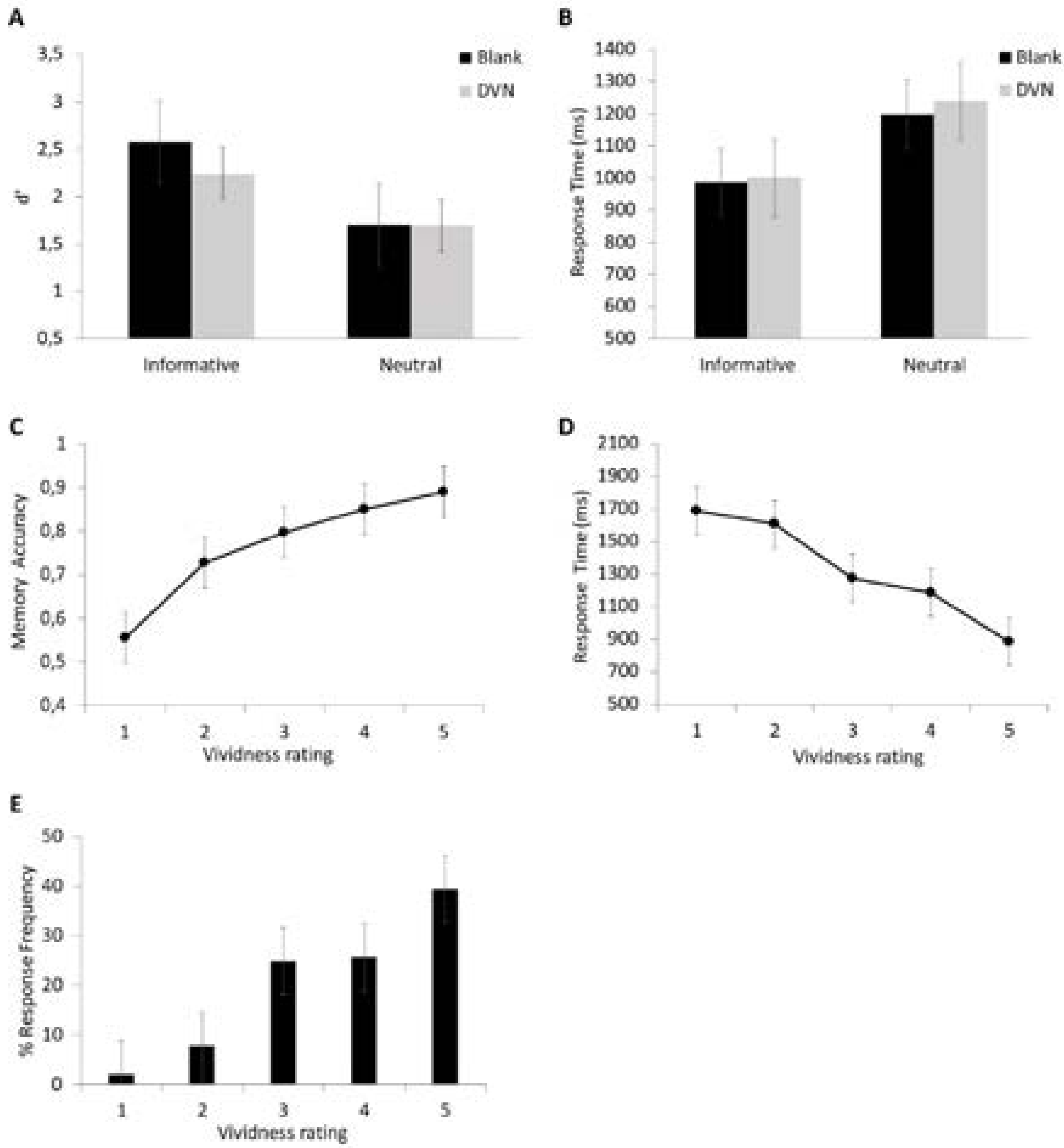

Figure 2. A) The mean of d' of memory recognition. B) The mean of Response Time of memory recognition. C) Correlation between the mean of recognition accuracy and vividness rating. D) Correlation between the mean of response time of the vividness rating and the vividness rating. E) Percentage frequency of response to vividness rating.

Discussion

In this study, we investigated whether orienting attention through the retro-cue to an internal visual representation stored in short term memory brings it to an active state that allows this representation to be consciously inspected. We expected that the representation retrieved from visual short term memory to the active state would be sensitive to a perceptual visual interference (DVN). We also supposed that the retrieved information, as a mental image, could be submitted to the conscious inspection needed for the vividness rating. Our results showed a significant

Retro-cue effect in memory recognition, but not in the vividness rating. The visual interference (DVN) is detrimental in the vividness rating, but not in the memory recognition. There was a high correlation between the vividness rating and the memory recognition test, and the response time in vividness rating was inversely proportional to the rating.

Recognition task. Our results showed the RCE in the memory recognition consistent with previous studies (Griffin & Nobre, 2003; Lepsien & Nobre, 2006; Souza et al., 2016). The RCE have been explained by several hypotheses (see Souza & Oberauer, 2016) and our results enable us to discuss some of these hypotheses. In our task, the participant should make the vividness rating before the recognition test, this order 'vividness-recognition' could allow maintaining the information in consciousness and prioritized for decision-making in the recognition test. If the information was conscious and prioritized then it reduces the comparison process in the recognition test, making the response faster and more accurate. In addition to the Prioritization Hypothesis, in the Hypothesis of Retrieval Head Start, the retro-cue may allow the gradual accumulation of evidence from the cued-item, which would make the decision-making more assertive (Souza & Oberauer, 2016). Once more, the vividness rating before the recognition test might contribute to this accumulation of evidence of the retro-cued item.

Another hypothesis suggests that the retro--cued item is protected to perceptual interference (Souza et al., 2016), our results showed that the DVN did not affect the recognition test. This hypothesis proposes that the retro-cued item is beneficial in FoA, and the un-cued items would be unprotected and easily submitted to perceptual interference (Souza & Oberauer, 2016). The presence of perceptual irrelevant information after the retro-cue presentation does not affect the recognition test. The retro-cue permit orienting the attention to the cued-item making this representation strong enough against visual interference (Makovski & Jiang, 2008). In the recognition test, the retrieved information will subserve a decision process and may be under the FoA, in an active state, but it would not necessarily involves a conscious mental image (Jacobs & Silvanto, 2015).

Vividness rating. Our results showed no RCE in vividness rating suggesting that the mental representation might not be generated from the retro-cue, but the retro-cued item could already have been in an active state. The information maintained in the active state can be manipulated in different ways, consciously as a mental image, or used as recognition and decision-making task (Fig.3.A). This explanation is associated with the proposal of Jacob, Jacobs and Silvanto (2015) about the attended and the conscious content in WM. The retro-cue state is active and involves the FoA, but not necessarily a phenomenological conscious, as a mental image.

The absence of the RCE in the vividness rating suggests that the phenomenological conscious information could be first retrieved as a global scene and not just a retro-cued item (fig. 3.B). Our results showed that the vividness rating is not different for the retro-cued item or for all the memorized items and the time of vividness rating does not differ between the retro-cued item and all items. There is a possibility that, when a mental image is generated the entire scene is brought to consciousness and not just the retro-cued item. After the entire scene is generated, it is possible to inspect or manipulate the mental image and prioritized the retro-cued item.

The DVN impaired the vividness rating implying that the generation of conscious mental images are sensitive to perceptual visual interference and may be generated within the same system responsible for both memory and mental representation (Pearson, 2001). The DVN effect has been found during the encoding and the retrieval periods, when the mental image can be generated and held in a system that is susceptible to visual interference (Quinn & McConnell, 2006; Valenti & Galera, 2020). The DVN impairment in informative and neutral conditions suggests that the perceptual interference had a general effect not only in retro-cued item but in all WM retrieved content. We supposed that vividness rating was performed on a conscious representation, which was not necessarily generated by the retro-cue.

Baddeley and Andrade (2000) also found that irrelevant visual information affected the vividness rating but not the memory performance, suggesting that the visual memory and the subjective experience of visual imagery reflect a different process. The double dissociation between visual imagery and visual memory is suggested in Van der Meulen, Logie e Della Sala (2009) study that shows a disruption of visual imagery but not visual memory by irrelevant visual information, while tapping task disrupt visual memory and not visual imagery.

The response time of vividness rating was inversely proportional to the rating, that is, the higher the vividness, the faster the response; the lower the vividness, the longer is the answer. This inverse correlation suggests that the mental image vividness may reflect the activation level of working memory system, as well as the speed of image generation may also be associated with quality, thus, a better visual quality allows more efficiency and speed in the recovery of the mental image (D'Angiulli & Reeves, 2002).

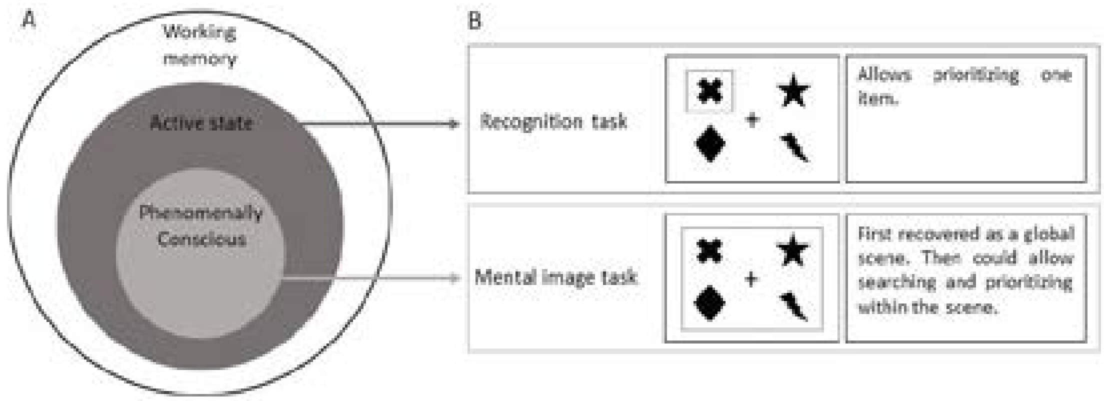

Fig. 3. Possible relationship among the content in WM. A) The content in an active state could be consciously inspected as in a mental image task, or could remain in an active state not available consciously, but available in decision-making as a recognition task. B) In recognition task the content could be in an active state which allows prioritizing one item of memoranda. In mental image task the content is an active state but it is first recovered as a global scene in mental image, and then one item could be prioritized within the scene.

Correlation between vividness and recognition. Different processes can be explained by different type of tasks and/or different cognitive process. Mental image and memory recognition are different and are not sensitive to the same interferences, but they are not entirely dissociated. Our results showed a positive correlation between the vividness rating and the performance in the recognition task. The more vivid the mental image, the higher the recognition accuracy of memory.

Studies with Aphantasia patients showed that performance in visual working memory tasks did not differ from the control group, but the use of strategies and the metamemory ability do change from control and aphantasia individuals (Jacobs et al., 2018; Pounder et al., 2021). That is, the processes involving WM tasks and mental image tasks are different, although they may share the same subsystem. Neuroimaging studies suggest the sharing activation of neural areas in perception, memory and imagination (Albers et al., 2013; Amedi et al., 2005; Kreiman et al., 2000; J. Pearson et al., 2011; Sheldon et al., 2017).

Limitations. Participants were not assessed for metacognition. We did not use articulatory suppression, although participants were instructed not to rehearse phonologically, but to try to visualize it. The time to encode the information may have been long enough to prevent the participant from using the retro-cue in vividness rating.

Conclusion

This study showed that the vividness of the mental image and the memory recognition present different cognitive processes and are submitted to different types of interference, but there is a correlation between them. The retro-cue might bring the information to an active state, which is not necessarily a phenomenological conscious mental image of the retro-cued item. This allows us to think about how the mental image is generated in working memory and whether is necessary to retrieve all the content instead only one item of the content of conscious mental representation. The difference between mental image and memory recognition processes is related to different types of tasks and how we request information in WM. Further studies are needed on the different ways in which we retrieve information from WM.

References

Albers, A. M., Kok, P., Toni, I., Dijkerman, H. C., & de Lange, F. P. (2013). Shared Representations for Working Memory and Mental Imagery in Early Visual Cortex. *Current Biology*, *23*(15), 1427-1431. https://doi.org/10.1016/j.cub.2013.05.065

Amedi, A., Malach, R., & Pascual-Leone, A. (2005). Negative BOLD Differentiates Visual Imagery and Perception. *Neuron*, *48*(5), 859-872. https://doi.org/10.1016/j.neuron.2005.10.032

Baddeley, A. (2007). *Working memory, thought, and action*. (pp. xviii, 412). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198528012.001.0001

Baddeley, A. D., & Andrade, J. (2000). Working memory and the vividness of imagery. *Journal of Experimental Psychology: General*, *129*(1), 126-145. https://doi.org/10.1037/0096-3445.129.1.126

Bona, S., Cattaneo, Z., Vecchi, T., Soto, D., & Silvanto, J. (2013). Metacognition of visual short-term memory: Dissociation between objective and subjective components of VSTM. *Frontiers in Psychology*, *4*. https://doi.org/10.3389/fpsyg.2013.00062

Bona, S., & Silvanto, J. (2014). Accuracy and Confidence of Visual Short-Term Memory Do Not Go Hand-In-Hand: Behavioral and Neural Dissociations. *PLOS ONE*, *9*(3), e90808. https://doi.org/10.1371/journal.pone.0090808

Cui, X., Jeter, C., Yang, D., Montague, P., & Eagleman, D. (2007). Vividness of mental imagery: Individual variability can be measured objectively. *Vision Research*, *47*(4), 474-478.

D'Angiulli, A., & Reeves, A. (2002). Generating visual mental images: Latency and vividness are inversely related. *Memory & Cognition*, *30*(8), 1179-1188. https://doi.org/10.3758/BF03213401

Dijkstra, N., Bosch, S. E., & van Gerven, M. A. (2019). Shared neural mechanisms of visual perception and imagery. *Trends in Cognitive Sciences*, *23*(5), 423-434.

Dijkstra, N., Bosch, S. E., & van Gerven, M. A. J. (2017). Vividness of visual imagery depends on the neural overlap with perception in visual areas. *Journal of Neuroscience*, *37*(5), 1367-1373. https://doi.org/10.1523/JNEUROSCI.3022-16.2016

El Haj, M., Gallouj, K., & Antoine, P. (2019). Mental imagery and autobiographical memory in Alzheimer's disease. *Neuropsychology*, *33*(5), 609.

Gayet, S., Guggenmos, M., Christophel, T. B., Haynes, J.-D., Paffen, C. L., Van der Stigchel, S., & Sterzer, P. (2017). Visual working memory enhances the neural response to matching visual input. *Journal of Neuroscience*, *37*(28), 6638-6647.

Griffin, I. C., & Nobre, A. C. (2003). Orienting Attention to Locations in Internal Representations. *Journal of Cognitive Neuroscience*, *15*(8), 1176-1194. https://doi.org/10.1162/089892903322598139

Hassin, R. R., Bargh, J. A., Engell, A. D., & McCulloch, K. C. (2009). Implicit working memory. *Consciousness and Cognition*, *18*(3), 665-678. https://doi.org/10.1016/j.concog.2009.04.003

Huang Y, Pollick F, Liu M, Zhang D. (2021) *Shared and Independent Neural Representation Between Visual Perception and Mental Imagery*. Research Square. https://doi.org/10.21203/rs.3.rs-788978/v1

Jacob, J., Jacobs, C., & Silvanto, J. (2015). Attention, working memory, and phenomenal experience of WM content: Memory levels determined by different types of top-down modulation. *Frontiers in Psychology*, *6*, 1603-1603. https://doi.org/10.3389/fpsyg.2015.01603

Jacobs, C., Schwarzkopf, D. S., & Silvanto, J. (2018). Visual working memory performance in aphantasia. *Cortex*, *105*, 61-73.

Jacobs, C., & Silvanto, J. (2015). How is working memory content consciously experienced? The 'conscious copy' model of WM introspection. *Neuroscience & Biobehavioral Reviews*, *55*, 510-519. https://doi.org/10.1016/j.neubiorev.2015.06.003

Keogh, R., & Pearson, J. (2014). The sensory strength of voluntary visual imagery predicts visual working memory capacity. *Journal of Vision*, *14*(12), 7-7. https://doi.org/10.1167/14.12.7

Keogh, R., & Pearson, J. (2018). The blind mind: No sensory visual imagery in aphantasia. *The Eye's Mind - Visual Imagination, Neuroscience and the Humanities*, *105*, 53-60. https://doi.org/10.1016/j.cortex.2017.10.012

Kosslyn, S. M., Ganis, G., & Thompson, W. L. (2001). *Neural foundations of imagery. Nature Reviews Neuroscience*, *2*, 635.

Kreiman, G., Koch, C., & Fried, I. (2000). Imagery neurons in the human brain. *Nature*, *408*, 357.

Lepsien, J., & Nobre, A. C. (2006). Cognitive control of attention in the human brain: Insights from orienting attention to mental representations. *Control of Attention and Actions*, *1105*(1), 20-31. https://doi.org/10.1016/j.brainres.2006.03.033

Li, Z., Tong, M., Chen, S., & Qian, J. (2021). Effect of attentional selection on working memory for depth in a retro-cueing paradigm. *Memory & Cognition*, *49*(4), 747-757.

Makovski, T., & Jiang, Y. (2008). Distributing versus focusing attention in visual short-term memory. *Psychonomic Bulletin & Review*, *14*, 1072-1078. https://doi.org/10.3758/BF03193093

Marks, D. F. (1973). Visual imagery differences in the recall of pictures. *British Journal of Psychology*, *64*(1), 17-24. https://doi.org/10.1111/j.2044-8295.1973.tb01322.x

McConnell, J., & Quinn, J. G. (2000). Interference in Visual Working Memory. *The Quarterly Journal of Experimental Psychology Section A*, *53*(1), 53-67. https://doi.org/10.1080/713755873

Nanay, B. (2018). Multimodal mental imagery. *Cortex*, *105*, 125-134.

Nanay, B. (2021). Unconscious mental imagery. *Philosophical Transactions of the Royal Society B*, *376*(1817), 20190689.

Niklaus, M., Singmann, H., & Oberauer, K. (2019). Two distinct mechanisms of selection in working memory: Additive last-item and retro-cue benefits. *Cognition*, 183, 282-302.

Pearson, D. G. (2001). Imagery and the visuo-spatial sketchpad. In *Working memory in perspective* (pp. 33-59). Psychology Press.

Pearson, J. (2019). The human imagination: The cognitive neuroscience of visual mental imagery. *Nature Reviews Neuroscience*, *20*(10), 624–634.

Pearson, J., Rademaker, R. L., & Tong, F. (2011). Evaluating the Mind's Eye: The Metacognition of Visual Imagery. *Psychological Science*, *22*(12), 1535-1542. https://doi.org/10.1177/0956797611417134

Pounder, Z., Jacob, J., Evans, S., Loveday, C., Eardley, A., & Silvanto, J. (2021). Individuals with congenital aphantasia show no significant neuropsychological deficits on imagery-related memory tasks. *PsyArXiv*, 1-22.

Quinn, J. G., & McConnell, J. (2006). The interval for interference in conscious visual imagery. *Memory*, *14*(2), 241-252. https://doi.org/10.1080/09658210500210019

Runge, M. S., Cheung, M. W., & D'Angiulli, A. (2017). Meta-analytic comparison of trial-versus questionnaire-based vividness reportability across behavioral, cognitive and neural measurements of imagery. *Neuroscience of Consciousness*, *2017*(1), nix006.

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime: A user's guide*. Psychology Software Tools.

Sheldon, S., Amaral, R., & Levine, B. (2017). Individual differences in visual imagery determine how event information is remembered. *Memory*, *25*(3), 360-369. https://doi.org/10.1080/09658211.2016.1178777

Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Applications to dementia and amnesia. *Journal of Experimental Psychology: General*, *117*(1), 34-50. https://doi.org/10.1037/0096-3445.117.1.34

Soto, D., Mäntylä, T., & Silvanto, J. (2011). Working memory without consciousness. *Current Biology*, *21*(22), R912–R913. https://doi.org/10.1016/j.cub.2011.09.049

Souza, A. S., & Oberauer, K. (2016). In search of the focus of attention in working memory: 13 years of the retro-cue effect. *Attention, Perception, & Psychophysics*, *78*(7), 1839-1860. https://doi.org/10.3758/s13414-016-1108-5

Souza, A. S., Rerko, L., & Oberauer, K. (2016). Getting more from visual working memory: Retro-cues enhance retrieval and protect from visual interference. *Journal of Experimental Psychology: Human Perception and Performance*, *42*(6), 890.

Thompson, E. (2007). Look again: Phenomenology and mental imagery. *Phenomenology and the Cognitive Sciences*, *6*(1–2).

Valenti, L., & Galera, C. (2020). Dynamic visual noise has the same effect on visual memory and visual imagery tasks. *Psychology & Neuroscience*, *13*(1), 114-125. https://doi.org/10.1037/pne0000183

van der Meulen, M., Logie, R. H., & Sala, S. D. (2009). Selective interference with image retention and generation: Evidence for the workspace model. *Quarterly Journal of Experimental Psychology*, *62*(8), 1568-1580. https://doi.org/10.1080/17470210802483800

Wilson, A. C., Schwannauer, M., McLaughlin, A., Ashworth, F., & Chan, S. W. (2018). Vividness of positive mental imagery predicts positive emotional response to visually presented Project Soothe pictures. *British Journal of Psychology*, *109*(2), 259-276.

Zerr, P., Gayet, S., van den Esschert, F., Kappen, M., Olah, Z., & Van der Stigchel, S. (2021). The development of retro-cue benefits with extensive practice: Implications for capacity estimation and attentional states in visual working memory. *Memory & Cognition*, 1-14.

Mariana Ribeiro Maniglia

Doutora em Psicobiologia pela Universidade de São Paulo (USP), em Ribeirão Preto, SP, Brasil. Psicóloga e professora no curso de Psicologia na Universidade de Ribeirão Preto (UNAERP), em Ribeirão Preto, SP, Brasil.

Psico, Porto Alegre, v. 55, n. 1, p. 1-12, jan.-dez. 2024 | e-42132

Cesar Alexis Galera

Doutor em Psicologia pela Universidade de São Paulo (USP), em São Paulo, SP, Brasil; com pós-doutorado pela Concordia University, em Montreal, Canadá. Professor Titular em Psicologia da Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto – Universidade de São Paulo (USP), em Ribeirão Preto, SP, Brasil.

Endereço para correspondência

César Alexis Galera

Universidade de São Paulo (USP)

Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto

Av. Bandeirantes, 3900

Vila Monte Alegre, 14040-900

Ribeirão Preto, SP, Brasil

Os textos deste artigo foram revisados pela SK Revisões Acadêmicas e submetidos para validação do(s) autor(es) antes da publicação.