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Investigating the effect of memory systems in recall when visual extraneous overloads impair Working Memory

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Abstract

The retain of information is depended to the levels of processing, the visual processes that are involved (when visual stimuli are concerned) and the memory systems that are interoperating with WM (Working Memory). A recent study showed that PPT [Power Point Presentation] which is the most widespread tool used in learning environments, and more specifically animated and decorative objects utilized for reinforcing the understanding of a current subject, may impose WM to an OIE (Overloading Impairment Effect) by reducing recall. Yet, cognitive effects which activate effective memory systems that may deactivate this OIE haven't been explored. The present study aimed to deactivate the OIE of PPT's animated and decorative objects by unfolding influencing cognitive effects (Semantic Priming Effect, Familiarity Effect and Emotionally Charged Words). 280 participants recruited for the present study and randomly divided into 4 groups to perform 4 different tasks: three recorded PPT to unfold the three mentioned cognitive effects with animated and decorative with Emotionally Charged Words; the IPSFSP [Interactive Participation in Story Formation through Semantic Priming] from previous research was reutilized as a control group for evaluation. Data were analyzed by using a 2 (Type of Stimuli) x 4 (Cognitive Effects) Mixed ANOVA. Statistical significance yielded for the superiority of the effect of threatening stimuli and Semantic Priming in recall. Unsatisfactory effect sizes may reveal the existence of the OIE which may led to non-significant interaction effect of the variables. Ultimate power achieved allows for secure concluding that priming of information led to its greater inculcation instead of its typical training, especially when an OIE is present.

Keywords:

Working Memory; Recall; Semantic Memory; Semantic Priming Effect; Visual Working Memory; Familiarity Effect; Emotional Memory; Emotionally Charged Words; OIE; PowerPoint Animated and Decorative Objects

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Introduction

Levels of processing and Memory Systems effects

Craik and Lockhart's [1] LPM (Levels of Processing Model) associates best recall of stimuli with their greatest, mental, inculcation; the depth of processing involved in STM [Short-Term Memory] predicts that the deeper the information is processed, the greater a memory trace will be inculcated in the LTM [Long-Term Memory] and thus, will last [2]. However, during STM temporarily information holding, the DSLP (Deep Semantic level of processing), as the meaning encoder, is considered to be the most effective for consolidating information, is not interacting with a wide range of cognitive effects that force shallower processing [3].

According to Nieznański [4], who extended the dual-recollection theory (perceptual recollection, context recollection, and familiarity) and sensory-semantic model (sensory semantic coding of stimuli) by using pictures and words separately and combined respectively for each approach, found that there is an effect of the DSLP in WM [5] and thus, to the levels of information attainment and recollection, in the combined task whereby there was a positive correlation. WM and its interaction with a plethora of cognitive effects results to a variety of outcomes regarding recollection of information and provides individuals with the abilities of organizing, planning, and executing.

As a "mental sketchpad" [6, p.411] WM shares an operational mechanism for the temporarily holding of representations of information with the STM [7; 8]. Studies have showed that the SPE (Semantic Priming Effect) [9], the FE (Familiarity Effect) [10] and the ECW (Emotionally Charged Words) [11] contain cognitive mechanisms that act as reinforcers of coding, storage and retrieval while SM (Semantic Memory) [12], VWM (Visual Working Memory [13] and EM (Emotional Memory) [14]-respectively when each cognitive effect- interoperates with WM. However, the interoperation of the abovementioned memory systems with WM may contain components that do not interact with the DSLP and may act as barriers in recall [15].

Extraneous loads and Overloading Impairment Effect

To conceptualize information attainment, recall and WM as codependent entities, the CLT (Cognitive Load Theory) [16] may be invoked. CLT is an evidence-based approach that focuses to minimize extraneous (reductive) loads for WM processing and capacity in an educational setting. Hawthorne et al. [17] yielded that when the cognitive architecture of brain which serves LTM and WM function, proposed by the CLT, is included in strategies of teaching, learning becomes effective. Extraneous loads are the actual means in which cognitive effects are unfolded for passing information to individuals through tasks such as reading or watching a presentation. Yet, typical ways of teaching tend to passively engage individuals, whereby a motivational cost and the non-exploitation of efficient cognitive processes emerges within passivity [18].

Despite the repeated calls for more interactive approaches that will reinforce recall [19], PPT presentations are still the most widely used tool in many learning environments. Studies have yielded positive correlations of PPTs utilization and learning attainment [20; 21]. It is showed that information attainment and recollection is reinforced with the use of relevant (or not) educational animations, whereas animated images seem to be more effective in stimulating individuals' cognitive mechanisms than still -digital or analog- images [22; 23]. However, Pink and Newton [24] recently argued that animated and decorative objects of PPTs can force WM to an OIE by minimizing attainment and recollection of information, unfolding the "Seductive Details Effect" [25, p. 112]. Seductive details can take the form of text, illustrations and animations and are interesting but not directed toward the learning objectives of a module. Rey [26] conducted a meta-analysis that found, overall, a negative impact for the inclusion of seductive details such as the aforementioned factors in learning. As far as the suggestion that extraneous visual loads increase recall but also force this OIE in WM [27], the cognitive background of visual processes may be discussed.

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Dorsal and Ventral streams effects

Regardless of the criticisms arguing for their malleability in illusions for the two bi-pathways processes [28; 29], Eysenck and Groome [2] acknowledged the Two-Stream Hypothesis [30] to explain the cognitive processing of visual static and motional stimuli. Dorsal stream provides a short-lasting representation of visual stimuli utilizing an allocentric coding of them through a bottom-up action [31]. Ventral pathway is specialized in motion information and animated objects and exploits a semantic egocentric coding of visual stimuli, as Alipour et al. [32] established. By utilizing a modified leaky integrator producing static and motion stimuli to activate both streams with semantic/motion stimuli and not semantic, static stimuli for enhancing learning, revealed that when semantic/motion stimuli are present, the meaning underlying them activates DSLP, enhancing ventral stream's process and long-term results are noticed in recall.

During the ventral stream's coding, the SM activations underlie the creation of mental representations which are long-lasting, a common function of LTM [33]. Irish and Piguet [34] yielded the significance of SM in remembering, when investigated recall, supporting their conclusion for a significant interaction between WM and SM. However, ventral stream is malleable to VWM activations [35; 36] when tasks such as a video projecting asynchronous stimulus, whereby the V5/MT area of the visual cortex, the principal element of detecting and signaling the presence of visual motion, may overload [37; 38]. If an extraneous load is visual and/or semantical, this will determine their transfer to the processing streams and different effects will unfold on reasoning, decision-making, behavior, conscious awareness, learning and recall [39; 40; 41]. PPT's animated and decorative objects seems to be reductors of recall as far as they can overload ventral stream's perceptual processing while individuals' cognitive mechanisms are struggling to control and manipulate information [42].

Manipulation of information and Working Memory

The ability of the manipulation of information achieved through Sensory Memory, lies solely in the function of WM [43]. WM 's role is to spread received data within its subsystems – central executive and phonological loop, episodic buffer, visuo-spatial sketchpad- [5] by utilizing the EB (Episodic Buffer) [45]. The EB is the distributor of data and storage of "downloaded" retrieved memories by the LTM [46, p. 836. The EB, as a mental sketchpad component holds the mental representations of data, resulted by SM activations, for communicating them to the LTM [47] so, a larger mental pool of available information can be utilized when recalling. However, consolidation of information in the LTM may qualitatively vary depending on the quality of the progress of processing when stimuli are flowing to the action and, especially, perceptual streams and the system of memory which interoperates with WM [48; 24; 49]. This dependency may also have a negative impact in the ability of WM to perceive relevant information as one chunk to serve its limited capacity (7±2 chunks of information) [50].

According to the MM (Multicomponent Model) [44] of WM there is a need to account beyond the mere activations of long-termed mnemonic traces and to presently focus on the better operation of WM components that will amplify the acquisition and manipulation of new information within spreader activations. A recent study [49] suggested that the SPE allows the interoperation of the SM and WM, yielding stronger mental representations and inculcations of stimuli, and better recall, whereas impairment effects, such as anxiety, may be deactivated [11]. Therefore, according to Jalani and Sern [51] to achieve visual and motion information strongest inculcation and to deactivate an OIE, extraneous loads used to reinforce recall may be utilized acknowledging essential cognitive mechanisms of individuals, such as the DSLP, for serving the operations of ventral stream and SM, and WM's ability of manipulation of information [1].

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Semantic Priming Effect and Semantic Memory

According to Zemla and Austerweil [52] when information is given hidden as a semantic prime visual stimulus semantically implying the information, better recall outcomes are grounded into the activation of semantic networks. During the time of SM processed such stimulus the EB interworks to retrieve semantic related data, whereby this cognitive mobility is correlated with hippocampus activations [53. However, this semantic process may decrease, because EM, also spotted in hippocampus and amygdala activations, may retrieve processes' negative emotions and may retrogradely act to this semantic predisposition [54]. Ladas et al. [49] supported Henry's [55] argument that the SPE can lead the EB to a novel episode of imprinting information; The IPSFSP task which used by utilizing words to act as semantic primes implying the target-words seemed to interacted with the DSLP, where information inculcated into clearer mental representations, and thus, information representation became clearer and WM's limited capacity expanded by touching higher scores of recalled chunks of information (20 chunks) [2; 49). Furthermore, by utilizing the IPSFSP task, despite its effectiveness in recall, evidence emerged also for the superiority of the interactive participation, such as guessing and writing the target-words in contrast to passive elaboration, supporting Vaahtoranta et al. [19] call for familiarizing individuals to more interactive approaches.

Familiarity Effect and Visual Working Memory

Nelson et al. [56] founded that individuals which are recruited to participate in familiar tasks with target words, a FE occurs, whereby recall increases in contrast to non-familiar tasks, concluding that the process of participating in it, a priming effect transpires which activates semantical networks. It has been reported that familiarity boosts the speed and/or efficiency of the egocentric perceptual coding of ventral stream [57]. Jackson and Raymond [48] by using famous faces to engage the VWM and to accompany the presentation of learning objects, again, they noticed that recall outcomes can be expanded, in contrast to e.g., stimuli presented audio-visually. This interoperation can positively stimulate the visuo-spatial sketchpad, a WM component which processes visuospatial stimuli [58] and Jackson and Raymond [48] suggested that the view of a famous face will strengthen attention, because as a stimulus is constituted by many details, and will reinforce the ability of WM and VWM to create units of information. However, Ruddy [59] when investigated the effect of familiarity with the use of famous video clips for reducing a seductive detail accompanying the targets, he noticed that individuals' recall ability remained decreased. VWM is malleable in non-familiar visual stimuli reflections. If the famous stimuli are unknown or may act as seductive detail for some individuals, VWM can be overloaded by the produced rapid changes in the blood oxygenation levels of parietal lobe's areas and decrease its already limited capacity, whereas anxiety may also be produced as an overloading after-effect (3-5 chunks) [61].

Emotionally Charged Words effect and Emotional Memory

According to Ritchey et al. [61] EM can be progressed in shallower or either into deeper levels of processing, dependably to elaborative or passive way that a task is given to individuals. Consolidating a negative content may be determined in a positive way [11].

Threatening stimuli, precisely because they contain threat, they capture attention and due to their produced arousal, the EB proceeds to a more detailed inculcation of data received. As it is mentioned, EM activations by ECW may retrogradely act if traits such as anxiety are predominant to individuals [62] yet, an impairment effect of anxiety may be decreased with the copresence of a task unfolding the SPE [49]. Ladas et al. [49] produced no statistical significance in the effect of ECW in recall whereby during the global lockdown for mitigating the SARS-CoV2 pandemic with physical distancing, their research turned to on-line methods, and despite the statistical significance that was yielded, a lot of criticism can be attracted. Yet, a recent metanalysis and a comparative study (63; 64) yielded no significant differences

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between online and in person methods regarding learning. Both agreed that more research is needed to increase the effectiveness of both methods.

Rationale

Extraneous loads, such as the PPT's animated and decorative objects, cannot always be reinforcers for WM operation and capacity by forcing WM to proceed to an OIE [24] whereby recall decreases. Similar decrease may present to tasks which promote passive elaboration of individuals when struggling to attain information [19]. In the favor of the CLT this study aims to deactivate the OIE -if there is one- of PPTs' animated/decorative objects [24] forcing semantic networks by unfolding the SPE [49] and FE [48] with the use of ECW [11]. The present study considers about the creation of a task to transform the reductive action of PPT's extraneous loads in reinforcers with the SPE. Following the protocol of the IPSFSP task, for utilizing words to semantical imply target-words [49], this study adapted the SPAOECW [Semantically Primed Animated Objects to Emotionally Charged Words] task, to utilize animated and decorative objects to semantical imply the target words. And so, to influence the SM to interoperate with EM and WM and thus, not to reject, but to convert extraneous reductive loads into positive primes. Furthermore, some aspects of the previous research of SPE [49] are reexamined regarding limitations which led to non-significant results. Experimental processes of this study lie in a cognitive setting to verify three experimental hypotheses: There will be a significant main effect of Type of Stimuli in recall, whereby threatening words will have a deactivating effect on the OIE and thus, will be recalled more than the neutrals; There will be a significant main effect of Cognitive Effects in recall, whereby the SPAOECW task by activating SM will reinforce recall by deactivating the OIE in contrast to the other tasks; There will be a significant interaction effect between the Type of Stimuli and Cognitive Effects, whereby the interworking of threatening words and SPAOECW will deactivate the OIE and reinforce recall in contrast to the other interactions of cognitive effects and memory systems.

Methods

Design

In this experimental design mixed measures (2 x 4 Mixed ANOVA) were used. The two levels (threatening and neutral target-words) within-independent variable: *Type of Stimuli*. And the four levels between-independent variable, *Cognitive Effects,* concerns four different experimental tasks which activate different cognitive effects: AODECW [Animated Objects, Decorated with Emotionally Charged Words]; IPSFSP; FFAODECW [Famous Faces and Animated Objects Decorated with Emotionally Charged Words]; and SPAOECW [Semantic Primed Animated Objects to Emotionally Charged Words]. The Working Memory Recall Ability will represent the only depended variable, by measuring the recall outcomes of extraneous loaded target-words.

Sample

According to the indication of G*power analysis (Appendix 1) for obtaining .80 of statistical power N should be 92 however, 280 participants (207 females, 70 males and 3 preferred not to say their gender, mean 28.2 and SD 8.74 of their age) have been recruited for the study (Appendix 2). Sample collection was opportunistic whereas the snowball technique was utilized. Including criteria recruited participants aged 18-62 following the including protocol of previous research (Ladas et al., 2020) who are capable to fluently use the English language and are capable to manipulate digital environments. Exclusion criteria rejected minor individuals or individuals who have vision impairments or chronic dizziness symptoms. Final exclusion criterion refers to individuals who reported anxiety issues, since the *Type of Stimuli* variable and the IPSFSP *of ECW* task, contain some lightly threatening aspects that may rise anxiety levels.

Materials

Participants, as well as the researcher utilized computers and internet connection, including web camera and microphone, so telecommunication become possible. Digital

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forms of the experimental tasks including all the necessary forms were shared through Google Forms, Social Media or teleworking applications (e.g., Microsoft Users). The main stimuli used and reflected to all the tasks are the ECW (Appendix 3) [11; 49] as a mean for forcing EM to activate and the cognitive effects to be activated and for testing their effects in recall ability. Animated and Decorative Objects [24] used in the tasks for understanding if there is an impairment effect results to decreased recall of the ECW (Appendix 4), but also to investigate the interaction of the OIE with different cognitive effects. Thus, two tasks regarding other cognitive influences were adapted. Famous Faces [48], as a central stimulus for capturing the attention, accompanied AODECW, to investigate the interaction of the OIE when VWM, and EM, are interoperate within the FE, activated by the Famous Faces (Appendix 5). Moving parallel with the idea of utilizing SPE by using words to semantically imply the ECW [49], Semantic Primed Animated Objects were used to semantically imply the target-words (Appendix 6) so to investigate the OIE within the SM and EM. Finally, for the task of the IPSFSP from the previous research [49] the unfulfilled story (Appendix 7) that used, whereby thirty target-words implied semantically by twelve words each, was re-utilized to compare the results into different and larger sample and cognitive effects.

Procedure

Participants were invited through phone calls, e-mails and social media communication. After their agreement for participating, four different links in Google Forms platform were given to each of them in order to provide them access to the four different tasks and to the necessary forms (Appendix 8) starting with the briefing and consent forms. For the AOECW, the FFECWAO and the SPAOECW participants were instructed to watch recorded PPT's presentations, one for each task. A difference between the three visual tasks reflects to the different type of stimulation of the thirty target-words (fifteen threatening and fifteen neutral). In the AOECW stimuli were given in a written form upon animated objects, whereas in the SPAOECW, as in a previous research was utilized words to semantically imply the target-words [49], this study used animated objects to do so. In the FFSPAO task, famous faces were used as a central stimulus for capturing the attention and for engaging the familiarity effect, whereas animated objects will carry on the stimuli. Target-words and objects will be presented in a white background for seven seconds, with a gap of five seconds between each target-word, following the time limits of stimuli presentation of previous research [49]For the IPSFSP, a typed story was given to them. Target-words were semantically implied by twelve words each of them. Participants were instructed to recognize the semantically implied target-words and fill them in the end of each sentence. After the completion of the tasks they procceded to the answering form to write down target-words they are able to recall, for three minutes. Finally, they were given access to the debriefing form for formulating their personal unique code and information regarding the purposes of the study as well as advices for how to manage diverse effects, if present, of the experimental procedures.

Ethical Considerations

The design of this study was framed with the ethical considerations propositioned by the BPS Code of Ethics and Conduct (2018). To guarantee that during the participation the individuals will feel comfortable with the existence of loads reflecting threat, such as threaten ECW and the IPSFSP task, they were aware for it and thus the possibility of surfacing anxiety and/or fear while interacting with such stimuli may by manipulated. To serve confidentiality, the collected data by each participant were transformed during the conduction of the present lab report into the total of numbers of recalled words. Furthermore, the corresponding author of the present study is the only one who has access to his personal computer, used for storage and manipulation of the emerged database. For anonymity to withstand, participants were included into the database with the use of a personal unique codes instead of using their names, surnames, and signatures, whereas the only information requested was about their age and gender for research pur-

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poses. Finally, the withdraw right allowing the participants to remove their data from the database and the study was notified to them both in the briefing/ debriefing forms and verbally. This study achieved risk assessment and a sign-off form (Appendix 9)

Data analysis and interpretation

Analytic strategy

Statistical analysis was performed using SPSS version 26.0. One mixed factorial ANOVA was used for the data to be analyzed. The design aimed to produce evidence for the advantages or disadvantages of the Type of Stimuli (independent within-subjects repeated variable), Cognitive Effects (independent between-subjects variable) and their interaction on the levels of recall (dependant variable). All three hypotheses were tested by conducting a F-test ANOVA for repeated measures, within-between interactions whereby statistical significance as well as the mean recall scores generated by the effect of the abovementioned independent variables will be interpretive of their effect on enhancing recall and on reducing the OIE of PPT animated and decorative objects. Furthermore, eta squared and omega squared effect sizes estimation were included in the analytic strategy in order to produce evidence regarding the magnitude of the effects of the variables within the OIE. Power analysis was also performed with G-Power version 3.1 to check the validity of the results.

Results

Data screening (Appendix 10) and check for parametric assumptions were performed. Despite some concerns indicated regarding normality on Kolmogorov-Smirnov and Shapiro-Wilk, all parametric assumptions were met (Appendix 11). However, to manipulate the normality issues and to secure the statistical validity of the study a parametric test was conducted on a stricter level of significance (a=.01) [65]. Table 1 shows the mean, SD, and totals of Type of Stimuli and Cognitive Effects variables.

Table 1 Mean, SD and Totals of type of stimuli (threatening and neutral words) and cognitive effects (Impairment effect, impairment effect and familiarity, impairment effect and semantic priming and story formation through semantic priming)

	AO-DECW	FFAO-DECW	IPSFSP	SPAO ECW	Stimuli Total
Threat-ening	5.72 (2.44)	5.01 (2.94)	4.30 (2.22)	5.97 (2.92)	5.25 (2.72)
Neutral	5.04 (2.71)	4.38 (3.23)	4.02 (2.41)	5.00 (3.34)	4.61 (2.96)
C Cogni-tive Total	5.38 (2.59)	4.70 (3.09)	4.16 (2,32)	5.48 (3.17)	

When exploring the existence of the OIE reflected by the animated and decorative objects of PPT [24], the emerged data yields satisfactory indications regarding the outcomes in recall when memory systems are interoperating. Comparing the totals of SPAOECW and FFAODECW tasks it appears that SM interoperabilities with EM and WM appears to have a greater effect on reducing the OIE, while VWM interoperability appears to contribute to its expansion. Results yielded by evaluating the effectiveness of the IPSFSP task which seem to be less reinforcing recall when it is not compared with typical audiovisual presentations [49].

Data were analyzed using a 2 (Type of Stimuli) x 4 (Cognitive Effects) mixed ANOVA (Appendix 12) whereas estimation of effect sizes and power analysis was conducted (Appendix 13) to investigate the recall ability of attained information extracted within the OIE of the animated and decorative objects of PPT. There was a significant main effect of Type of Stimuli in recalling ($F(1,276)=23.1$, $p=.001$, $\eta 2= .01$, $\omega 2 =.00$, power=1.00). More specifically, animated object decorated with threatening loads, despite the anxiety surrounded by threat that may act as a recall reductor, were recalled more than the animated objects decorated with neutral loads. There was a significant main effect of Cognitive Effects in recalling ($F(1,276) = 4.05$, $p = .008$, $\eta^2 =.03$, $\omega^2 =.00$, power=1.00) whereby more loads were recalled in parallel to the interoperation of SM within the SPAOECW task. There was no interaction effect between Type of Stimuli and

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Cognitive Effects in recall (F(3,276)= 1.17, p = .321, η^2 =.00, =-.00, power =.98).

Discussion

The study aimed to deactivate the OIE which is unfolded by the animated and decorative objects of PPT, by applying cognitive effects for forcing memory systems to act as deactivators to the OIE and recall reinforcers. Statistical significance yielded the effective role of SM activated by the SPAOECW task, as an interoperator to WM for recalling attained information in a digital and online environment in contrast to the VWM. EM has also an effective interoperating role, leading the threatening loads to be recalled more than the neutrals on every level of the Cognitve Effect variable. Moreover, despite the results of previews research yielding for the effectiveness of the IPSFSP in recalling information [49], the present study demonstrates the weakness of the task to lead individuals to touch higher scores of recall outcomes. Regarding the interaction between the Type of Stimuli and Cognitve effects, no significant interaction effect emerged and therefore, two out of three hypotheses was confirmed. However, a positive effect emerges from the interoperation of SM, EM and WM acknowledging the fact that more threatening words were recalled in the SPAOECW task.

Memory Systems, DSLP and the Two-Stream Hypothesis

The study raised awareness regarding the effective role of the SM and the SPE, unfolded by the utilization of the SPAOECW task, as the valuable interoperating memory system and cognitive effect respectively to WM [49]. Hawthorne et al. [17] argument was validated, whereby the abovementioned task may succeed to involve the relevant cognitive architecture for serving the information holding hence, the SPAOECW task fulfilled the required function of the CLT which aims at the better functionality of the WM, reducing the reductive action of the extraneous loads [16]. Both cognitive phenomena (SM and SPE) are involving the DSLP, according to which information consolidation is determined in a stronger inculcation [3] and led individuals into good standards of recall within the OIE of PPT animated and decorative objects. Therefore, SPE may be considered the most prominent cognitive effect in reducing the OIE and in assisting the creation of chunks of information, acknowledging the operational maximization of information inculcation by the EB, when SPE occurs in a task [55].

Another argument, yielding for the effectiveness in recall when utilizing PPT with educational animated images and objects relevant or not to the target words was endorsed, at least according to the results (5.48) produced by the SPAOECW task, utilizing animated objects to semantically imply the target words [22; 23]. However, the results yielded by the FFAODECW task (4.70) contradicts the abovementioned argument, whereby famous faces as irrelevant objects to the target words, led to the expansion of the overloading. Hence, VWM activated by the FFAODECW task, is evidenced to have a negative interoperating role to WM. By comparing the means of recall between the AODECW and SPAOECW tasks, not enough evidence is made for supporting Pink and Newton's [24] argument for the existence of the OIE unfolded by the PPT's animated and decorative objects. Medium effect size (0.52) produced in the recollection of animated objects and decorative information of the last-mentioned research still retains turbidity around the OIE. The fact that none of the participants scored 20 recalled words as Eysenck and Groome [2] and Ladas et al. [49] suggested that can be happen under the influence of the SPE, may also reveals the presence of the OIE, which blocked this capability. The SPAOECW task produced a slight quantitative advantage in recall in contrast to the AODECW (5.38). However, the interoperation of the EM forced to be activated by the threatening stimuli in the tasks, may have acted as a masker of the OIE.

The present research added to the literature the finding that when the pictures act as a semantic prime to the word, if the word is the intended target, the activation of targeted semantic networks [52] will amplify memory stages of encoding, storage, and retrieval. Furthermore, SPE seemed to reduce the impairment effect of anxiety that may be unfolded by the threatening ECW, activating the EM, validat-

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ing Ladas et al. [49] argument for the impairment reductor role of the SPE. This finding contradicts Vogel and Schwabe [62] argument for the predominance of anxiety reflected by the threats and validates Ritchey et al. [61] results. The conclusion of Vogel and Schwabe [62] is may characterized as weak, precisely because it emerged by the literature review on the action of negative emotions in memory. On the contrary, Ritchey et al. [61] produced a high partial eta squared (.92) on the emotional arousal to memory, which explains that an emotional reaction to a threat, may highly captures attention and maximizes the operation of EB, precisely because EM activated by the ECW was progressed into the DSLP, activated by the SPE in the SPAODECW task.

Nieznański's [4] argument for the inferiority of the DRT (dual-recollection theory) and superiority of the SSM (sensory-semantic model) in influencing recall was validated, whereby familiarity extracted by the DRT led to non-significant statistical effect in contrast to the semantical influence forced by the SSM. According to the latest model, tasks that combine relevant pictures to words will have an effect of Deep Semantic levels of processing in recall. Furthermore, the inferiority of the DRT, which bases on the assumption that familiarity will reinforce the recollection of information was also emerged, turning the discussion to narrow down in an opposite direction to the findings of Jackson and Raymonds [48] and Nelson et al. [56] yielding for the effectiveness of the FE to reinforce the recall process. More specifically, at least within a suggested OIE, the FFAODECW task which activated the VWM, acted as an expander of the OIE instead of acting as a compressor. Low mean number of recall score (4.70) produced by the abovementioned task supports Ruddy's [59] finding conceded for the seductive detail role of familiar stimuli that decreases recall and overloads VWM, bringing also to the scope the small partal eta squared (.39) produced by Jakcson and Raymonds [48] which reveals the weakness of the VWM on assisting memory stage of retrieval. Hence, relevant evidence partially transpired for the cognitive background of the suggested OIE, locating overloading: to the VWM capacity, recognizing the fact that VWM is malleable in stimuli reflections, by the suggested rapid changes in the blood oxygenation levels of parietal lobe's areas when VMW overworks during the exposure to a combination of stimuli [60], and to the V5/MT area and the visuo-spatial sketchpad, which may be overloaded when process animated objects, target words and static stimuli of famous faces [37; 58], whereby the latest mechanism did not serve the inculcative function of the EB. The IPSFSP task having a semantic structure, produced the lowest outcomes regarding recall. This fact overlaps with Alipour et al.'s [32] findings. The IPSFSP task contained the semantic mechanism to influence the egocentric coding of the ventral stream. However, the task as a static visual stimulus it may also influenced the allocentric coding of the dorsal stream, which is responsible for processing static stimuli, producing short-term representations of information, acknowledging the short-term retention of information by the dorsal stream [31]. Similar hypothesis can be made also for the FFAODECW task whereby despite the projections of animated and decorative objects within the task, famous faces projected as static stimuli, involving processes related to the dorsal stream and prevents individuals from reaching the semantic predisposition to extract information resulting from the semantic egocentric stimuli coding of the ventral stream [42]. Hence, Colombo et al.'s [57] argument that familiarity boosts the speed and/or efficiency of the egocentric perceptual coding of the ventral stream may be rejected.

Power analysis and effect sizes interpretation

Ultimate power that emerged from both the two main (type of stimuli power=1.00; cognitive effect power=1.00) and interaction (power =.98) effects allows for a secure and valid conceptualization of the results, acknowledging the absence of statistical errors. Statistical significance and mean numbers yielded for the superiority of the threatening Type of Stimuli and the SPE on reinforcing recalling and therefore, yielded for the effectiveness of the interoperation of EM, SM and WM on leading individuals to touch recall standards of 7±2 within the OIE. However, this emerged interoperation of memory systems is not grounding on a significant interaction effect. Non statistical significance for the interaction effect of the Type

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of Stimuli and Cognitive Effects variables may followed as a result, extracted by the OIE suggested by Pink and Newton [24]. This reductive effect may overshadow the operation of the Cognitive Effects and Type of Stimuli, a fact that is may revealed by the small and unsatisfactory effect sizes.

Partial evidence regarding the existence of the OIE in the PPT environment may be hidden and be explained by the small and unsatisfactory magnitudes of effect that emerged. Small eta squared resulted in both main and interaction effects tells that the variables and especially the cognitive effects accompanied by, despite the ultimate power that appeared, did not succeeded to influence individuals' recall in greater standards. Therefore, this statistical indication may put on the scope the OIE issue in the online or digital environment created by the animated and decorative objects of PPT, which may does not allow variables to unfold their effects to the maximum. This may be validated by the small partial eta squared (Appendix10) emerged by the non-significant interaction effect of the two main variables, which may explain the existence of the OIE, translated to a statistical error. Following the small degree of effect sizes, small omega squared does not allow the results to represent the general population. This fact may validates the presence of the OIE and possibly invites experts to use tasks and materials that will utilize the cognitive abilities of individuals rather than seeking to adapt them to the intended goal, acknowledging firstly that PPT are the widespread tool used for learning and secondly, that an OIE may be extended during PPT's utilization.

Limitations

A significant factor that may be considered as a barrier to the significance of the results, concerns the methodological approach of the present study, whereby experimental tasks executed through online methods which are by definition uncontrolled by the researchers in contrast to the experimental-control offered by conducting experiments with the physical presence of individuals. However, according to Paul and Jefferson [64] and Pei and Wu [63], arguing for no statistical differences between online and in person methods regarding learning, and importantly relying on the ultimate statistical power of the present analysis securing the validity of the outcomes, the methodological approach of this study may be considered as suitable. Another limiting factor of the present study concerns the fact that all PPT presentation tasks were accompanied by the presence of a cognitive effect. Hence, what was achieved was to observe the interaction of the OIE with the cognitive effects rather than to observe the OIE in isolation. In relation to the understanding of the cognitive structure of the OIE that was not succeeded, likewise the same could be considered for the cognitive structure of the extraneous loads.

Unexpectedly, because the only interactive task (IPSFSP) of the study led to lowest recall outcomes, the rejecting results of Vaahtoranta et al.'s [19] calls for interactive approaches emerged, and two reason are founded to be under the scope. Firstly, the presence of cognitive effects in the other tasks, such as the SPAOECW, that had the power to influence individuals deeper intrapersonal cognitive mechanisms, despite the fact of approaching individuals in a passive way, may be created a different distribution in the overall results of the study. Secondly, a limiter to the inability of the IPSFSP task to influence WM may lie in the fact that the story used was translated from Greek into English without giving a good semantical standard. This is supported by the fact that several of the participants were led to different semantic impressions of the requested target words.

Suggestions for future studies

The present study aimed to explore the deactivating effect of SM, VWM and EM in the OIE of animated and decorative objects and thus, discussion focused on the outcomes emerged by the interactions of memory systems within the OIE. Future studies may consider to explore the OIE in isolation without receiving interference from cognitive effects by involving individuals in simpler tasks. Same belief may be adjusted to investigate the effect of memory systems in recall within an environment whereby overload arises and

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when isolated instead of interoperated as happen in the SPAOECW and FFAODECW tasks. Thus, tasks that will activate lesser memory systems may be adapted. This study, considered issues regarding the cognitive and educational psychological settings around learning and memory, makes a call to cognitive and educational professionals to evaluate the present study, acknowledging the fact of the need for adapting both on-line and in person methods, including at least two more statistical analyses considering variables such as the age and the gender of participants, and confronting variables such as attentional bias and/or distractors. More statistical analysis may also refer on different memory systems, including tasks that will produce evidence about the interoperation e.g., of Episodic Memory and Procedural Memory, which both seem to have a significant correlation with the memory systems investigated in the present study, to open the scope regarding the suggested OIE. Lastly, a longitudinal approach, including also more synthetical analysis, should raise better awareness when investigating such complex structures and overlapping phenomena.

Conclusion

Priming tasks that aim to activate cognitive mechanisms that will lead individuals to extract information seem to have a statistically significant effect on recall from tasks attempting to train individuals through the immediate provision of information on the ground to shallower cognitive pathways. A task that may involve individuals in a passive role, may be more effective from a task posing individuals in interaction, dependently to the cognitive effects that are accompanying the task. The task of this study extracted evidence regarding the effectiveness when influencing the following cognitive structures: the DSLP, the ventral stream, the V5/MT area, the EB and the amygdala in recall. The abovementioned effectiveness was succeeded, serving the purposes of CLT and MM with the use of animated and decorative objects, which pose an OIE, used as semantic primes to the target words, especially for the threatening words, by leading the SM, the EM and the WM to an episodic and strengthening interoperation whereby recall is reinforced.

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