UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
INSTITUTO DE PSICOLOGIA
PROGRAMA DE PÓS-GRADUAÇÃO EM PSICOLOGIA

PENSAR OU NÃO PENSAR: POTENCIAIS CORTICAIS NA SUPRESSÃO DE MEMÓRIA

Camila Arguello Dutra

Dissertação de Mestrado

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“In the practical use of our intellect, forgetting is as important as recollecting.”

William James

"A retentive memory may be a good thing, but the ability to forget is the true token of greatness."

Elbert Hubbard

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RESUMO

O esquecimento intencional pode cumprir uma função estratégica no sistema cognitivo, que permite aos indivíduos não pensar sobre acontecimentos indesejados do passado, tais como eventos traumáticos, dolorosos e violentos, dos quais se prefere não recordar. Enquanto esquecer involuntariamente é uma falha da lembrança, por outro lado, esquecer intencionalmente parece ser uma função estratégica da memória. A presente dissertação teve por objetivo investigar os mecanismos neurocognitivos que contribuem para o esquecimento de memórias. A dissertação se organizou em dois estudos. O primeiro estudo consiste em uma revisão sistemática de artigos empíricos publicados nos últimos dez anos sobre a supressão de memórias indesejadas. O segundo estudo é um ensaio empírico, no qual foi executado um experimento adaptado do paradigma *Think/No-Think* com a utilização de marcadores eletrofisiológicos de eletroencefalograma. Participaram do experimento 22 sujeitos, alocados aleatoriamente em dois grupos com estratégias distintas de esquecimento: Supressão de memória e substituição de pensamentos. Durante toda a tarefa experimental, os participantes tiveram dados de EEG continuamente gravados. Os resultados decorrentes do ensaio empírico estão de acordo com os achados da literatura, indicando que a positividade parietal em torno de 400-800ms após a apresentação do estímulo é um marcador de lembrança consciente durante a recuperação de memória. Apenas na estratégia de supressão de memória houve uma redução da positividade centro-parietal durante o esquecimento, entre 450 e 700ms após apresentação do estímulo. Além disso, uma maior deflexão no componente N2 durante a supressão é um preditor de esquecimento induzido. Os achados indicam que é possível mapear o sistema neurocognitivo subjacente à supressão de memórias.

Palavras-chave: Supressão de memória, ERP, EEG, controle inibitório, Think/No-Think.

ABSTRACT

Intentional forgetting can be characterized as a strategic function of the cognitive system that allows us not to think about unwanted memories from our past, as for example emotional events or traumatic experiences that we would prefer not to remember. While forgetting involuntarily is a failure of recollection, on the other hand, forgetting intentionally seems to be a strategic function of memory. The aim of this dissertation was to investigate the neurocognitive mechanisms that contribute to forgetting memories. The dissertation was organized in two studies. The first study consists of a systematic review of empirical articles published in the last ten years on the suppression of unwanted memories. The second study is an empirical essay, in which an experiment adapted from the Think/No-Think paradigm was performed, with the use of electrophysiological markers of electroencephalogram. Twenty-two subjects participated in the experiment, randomly assigned to two groups with distinct strategies of forgetting: Memory suppression and thought substitution. Throughout the experimental task, participants had continuously recorded EEG data. The results of the empirical essay are in agreement with the literature findings, indicating that the parietal positivity around 400-800 ms after the presentation of the stimulus is a marker of conscious memory during memory recovery. Only direct memory suppression reduced centro-parietal positivity during forgetting, between 450 and 700 ms post-stimulus. Also, a greater deflection in the N2 component during suppression is an induced forgetting predictor. The findings indicate that it is possible to map the neurocognitive system underlying memory suppression.

Key words: Memory suppression, ERP, EEG, inhibitory control, Think/No-Think.

APRESENTAÇÃO

A capacidade humana de lembrar e o fato de esquecer são tópicos de pesquisa com longa tradição na psicologia científica, desde Ebbinghaus (1885). O esquecimento tradicionalmente é compreendido como uma falha de memória resultante de um processo passivo. Entretanto, pesquisas atuais demonstram que é possível esquecer intencionalmente algo aprendido (Anderson & Hanslmayr, 2014; Waldhauser, Bauml, & Hanslmayr, 2014; Anderson & Green, 2001).

Nem todas as memórias são recuperadas por vontade consciente, e algumas delas são de fato indesejáveis para quem lembra, chegando a interferir no funcionamento cognitivo normal. Trata-se de memórias intrusivas, geralmente relacionadas a um conteúdo emocionalmente intenso, possivelmente traumático (Ehlers, 2010). O esquecimento intencional pode cumprir uma função estratégica no sistema cognitivo, que nos permite não pensar sobre acontecimentos indesejados do passado, tais como eventos traumáticos, dolorosos e violentos, dos quais preferimos não recordar (Macklinger, Parra, & Waldhauser, 2008). A vantagem adaptativa neste caso seria manter disponíveis recursos de processamento perceptual, mnemônico e atencional que, de outra forma, seriam ocupados pelas representações intrusivas de eventos passados não relevantes para a situação atual. Normalmente, somos capazes de controlar quais memórias autobiográficas irão ocupar num dado momento a consciência, entretanto, quando não se consegue operar intencionalmente esse tipo de controle, a saúde mental pode ser prejudicada (Noreen & MacLeod, 2013).

Enquanto esquecer involuntariamente é uma falha da lembrança, por outro lado, esquecer intencionalmente parece ser uma função estratégica da memória (Wylie, Fox, & Taylor, 2008). O elemento central do processo cognitivo ativo do esquecimento é a capacidade de controlar a recuperação de memórias indesejadas. Alguns pesquisadores afirmam que a habilidade de reter a recuperação de informações irrelevantes, bem como a evitação voluntária de memórias, estão sustentadas por mecanismos de controle inibitório (Anderson, 2005). Na prática, é possível visualizar tal procedimento quando as pessoas são solicitadas a esquecerem informações que aprenderam previamente, demandando, assim, que a recuperação da informação seja evitada (Bjork & Bjork, 2003). A supressão, por sua vez, exige que os sujeitos interrompam a evocação, resultando em evitação da recordação consciente.

A capacidade de inibir voluntariamente memórias pode ser adaptativa, uma vez que permite limitar a influência de distratores na representação. Desse modo, é possível regular a

acessibilidade de lembranças desagradáveis ou intrusivas, proporcionando uma base mecanicista para uma forma voluntária de supressão (Levy & Anderson, 2002).

A fim investigar experimentalmente processos de controle inibitório sobre a memória, Anderson e Green (2001) desenvolveram o paradigma chamado "*Think/No-Think*" (TNT). O procedimento permite testar se é possível treinar sistematicamente as pessoas para que elas esqueçam informações sobre materiais expostos previamente.

A tarefa experimental no TNT inicia com a fase de aprendizado, na qual os participantes devem estudar um conjunto de pares estímulo-alvo (p. ex.: barril-jardim), sendo treinados a recordar a segunda palavra (jardim), quando expostos à primeira palavra estímulo (barril). Ao treinar os participantes desse modo, os autores esperam que a palavra da esquerda atue como uma pista eficaz. Quando a maioria dos itens alvo é recordada através da visualização da pista, inicia-se o próximo passo. Essa fase é composta pela tarefa "*Think/No-Think*", a qual requer que os sujeitos exerçam controle sobre a evocação. Apenas pistas dos pares associados são apresentadas, havendo uma condição em que os participantes são instruídos a evocar a resposta (condição *think*) ou são advertidos a evitar a evocação (condição *no-think*). Para a condição *no-think*, as instruções são de evitar uma resposta vocal e impedir que o item entre na percepção consciente de qualquer modo. Uma terceira condição (*baseline*), na qual os pares de itens são apenas mostrados na fase de aprendizado também é apresentada. Finalmente, para medir a expressão comportamental da supressão da evocação, todos os estímulos são demonstrados novamente (*think, no-think* e *baseline*) e é solicitado aos participantes que recordem a memória-alvo para cada um.

Anderson e Green (2001) descobriram que o desempenho de recordação foi significativamente mais alto na condição "*think*", quando comparado à "*baseline*". Ao mesmo tempo, a recordação na condição "*no-think*" foi significativamente pior, comparada à "*baseline*". Sendo assim, enquanto a memória na condição "*think*" foi facilitada, aquelas referentes à condição "*no-think*" foram enfraquecidas, quando comparadas aos itens que não receberam instruções alguma (*baseline*). Numerosos estudos subseqüentes descobriram que os itens *"no-think"* são menos recordados em testes de memória, esse efeito é chamado de esquecimento induzido pela supressão (Anderson & Green, 2001; Anderson et. al., 2004). Os achados indicam que as informações podem ser suprimidas através do controle inibitório durante a tarefa, corroborando com a suposição de que esse pode ser voluntariamente recrutado.

Além disso, tem sido demonstrado em estudos que utilizaram o paradigma, que a falha de memória na condição "*no-think*" não é dependente de pistas, uma vez que, mesmo quando

a palavra a ser recordada era semanticamente semelhante à pista, houve maior dificuldade de recuperação da informação. Isso indica que o prejuízo da memória não ocorreu devido à interferência associativa, a qual é causada por competição entre memórias diferentes, senão que é melhor explicado pela própria supressão da memória (Anderson, 2005).

Pesquisas que utilizaram ressonância funcional magnética (fMRI) em participantes que desempenharam as tarefas do paradigma TNT encontraram dissociações na ativação de sistemas neurais entre as tarefas *think* e *no-think.* O circuito mais ativado na condição *no-think* incluiu áreas dorsolateral bilateral e ventrolateral do córtex pré-frontal e o córtex cingulado anterior (Anderson et al., 2004). Tais áreas se sobrepõem fortemente àquelas com maior ativação durante a supressão da resposta motora (Menon, Adleman, White, Glover, & Reiss 2001). Esses dados indicam a possibilidade de que os sistemas neurais que estão envolvidos em respostas motoras também fazem parte do controle da recuperação de memórias (Anderson, 2005). Também, foi mostrado que a ativação na área do hipocampo é reduzida durante a supressão (Anderson et al., 2004), tal área é fundamental para a formação e recuperação de memórias (Squire, 1992). Essas evidências demonstram os indivíduos são capazes de regular intencionalmente a ativação hipocampal para desconectar a recordação.

Bergstrom, Fockert e Richarson-Klavehn (2009) investigaram potenciais relacionados a eventos (ERPs) como evidências para a capacidade de suprimir memórias indesejáveis. Os ERPs são alterações na atividade do eletroencefalograma (EEG) que permitem identificar a atividade cortical específica quando o indivíduo é exposto a determinados estímulos ou condições experimentais em tarefas cognitivas. Bergstrom e colaboradores (2009) verificaram que a supressão da memória reduziu a positividade centro-parietal nos ERPs entre 300 e 600 ms pós-estímulo, consistente com uma redução no ERP correlacionado à recuperação.

Os resultados encontrados por Bergstrom et al. (2009) sugerem que as instruções de supressão foram bem-sucedidas no sentido de incentivar os participantes a utilizarem mecanismos inibitórios para parar a recuperação de memórias. A supressão da memória foi associada com uma redução na positividade do ERP para a condição *no-think*. A positividade parietal em torno de 400-800ms após a apresentação da pista é um marcador de ERP de lembrança consciente durante a recuperação da memória (Friedman & Johnson, 2000; Rugg, 1995; Rugg & Curran, 2007).

Outro importante correlato eletrofisiológico encontrado em tarefas que demandam supressão de estímulos foi o componente N2, o qual mostrou maior deflexão durante a supressão da recuperação do que durante a recuperação. Essa deflexão na expressão do componente N2 prediz melhor eficácia no esquecimento induzido pela supressão

(Mecklingeret. al, 2009). O estudo de Mecklinger e colaboradores (2009) constatou que a magnitude do aumento do componente N2 durante *trials* de parada de resposta motora estavam correlacionados com as respostas de supressão em tarefas de memória, indicando que os controles motor e mnemônico possuem mecanismos de ações subjacentes. Deste modo, os achados sugerem que o esquecimento diante a supressão intencional foi bem-sucedido.

Em suma, existem diversas evidências de que a supressão da recuperação pode ser captada por marcadores eletrofisiológicos, os quais apontam o sucesso dos indivíduos em controlar a recuperação da memória. Além disso, esses marcadores fornecem informações úteis sobre os mecanismos que estão por trás do esquecimento motivado, corroborando com dados obtidos através de ressonância magnética funcional.

Estudos vêm demonstrando que evitar a recuperação de memórias indesejáveis aumenta a probabilidade de que essas memórias sejam esquecidas posteriormente (Bergstorm et al., 2009; Anderson et al., 2004), engajando mecanismos de controle pré-frontais para atenuar a atividade hipocampal. Entretanto, os mecanismos que previnem a recuperação da memória e o modo como se relacionam com o esquecimento posterior ainda não foram totalmente compreendidos.

Existem diversas maneiras pelas quais as pessoas podem tentar impedir que uma memória venha à mente. Pesquisadores da área acreditam que diferentes estratégias para prevenir a recuperação estão associadas a mecanismos qualitativamente distintos de esquecimento (Bergstorm et al., 2009). Deste modo, o presente estudo pretende buscar evidências neurais e comportamentais de estratégias distintas para impedir a recuperação de memória: a supressão e a auto-distração por meio de substituição de pensamentos.

A presente dissertação tem por objetivo investigar os mecanismos neurocognitivos que contribuem para o esquecimento de memórias. A investigação consta com a manipulação de tarefas do paradigma TNT, em uma população não-clínica. Objetiva-se, ainda, mapear os ERPs eliciados durante o experimento nas condições *think*, *no-think e baseline*, em duas estratégias distintas para impedir a recuperação de memória: a supressão de memória e a auto-distração por substituição de pensamentos.

Para atender aos objetivos propostos, a dissertação se organiza em dois estudos. O primeiro estudo consiste numa revisão sistemática de artigos empíricos publicados nos últimos dez anos sobre a supressão de memórias indesejadas. Foram analisados artigos que utilizaram o paradigma TNT, destacando seus resultados quanto a indicadores eletrofisiológicos. A expectativa com a revisão sistemática foi de que seus resultados informariam a estratégia experimental e as hipóteses do estudo empírico.

O segundo estudo é um ensaio empírico, no qual foi executado um experimento adaptado do paradigma TNT com a utilização de marcadores eletrofisiológicos de EEG.Em relação às variáveis de desfecho, as principais hipóteses de pesquisa foram: a) o desempenho de recordação seria significativamente mais alto na condição "*think*", quando comparado à "*baseline*". Ao mesmo tempo, a recordação na condição "*no-think*" seria significativamente mais baixa, comparada à "*baseline*"; b) em relação aos marcadores eletrofisiológicos, apenas a estratégia de supressão de memória apresentaria aumento no potencial correlacionado à recuperação de memória, ou seja, maior positividade centro-parietal, para a condição *"think"*; c) o componente N2, correlacionado com parada de resposta motora, apresentaria maior deflexão em sujeitos que utilizaram da estratégia de supressão de memória e d) haveria diferença qualitativa entre correlatos de ERP eliciados na estratégia de supressão e de substituição de pensamentos.

O estudo é experimental, composto por um delineamento fatorial 3 x 2, sendo um fator intra-sujeito com três níveis (condição *think, no-think, baseline*) e um fator inter-sujeitos com dois níveis (estratégia de supressão de memória e estratégia de substituição de pensamentos). Participaram do estudo 22 indivíduos de ambos os sexos, obtidos de forma não-probabilística, por conveniência. Foram incluídos sujeitos com idades entre 18 e 40 anos. Foram excluídos sujeitos que: (1) apresentaram sintomas graves de depressão ou ideação suicida (Escore total BDI-II maior que 29; escore $\geq$ 1 no Item 9, respectivamente); (2) apresentaram presença de sintomas psicóticos; (3) relataram histórico de dificuldade de aprendizagem; e (4) canhotos ou ambidestros. Cada participante foi designado por sorteio a um dos dois grupos experimentais, recebendo instruções para responder à tarefa utilizando respectivamente a estratégia de supressão ou substituição de memória.

O Termo de Consentimento Livre e Esclarecido foi assinado inicialmente e os demais instrumentos aplicados posteriormente à tarefa experimental. Com os participantes que preencheram os critérios de exclusão, uma entrevista de devolução foi agendada, caso necessário foi realizado encaminhamento para as instituições cabíveis.

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CAPÍTULO I

EEG evidence for memory suppression: A systematic review

Abstract

Understanding how people forget is one of the fundamental goals of the science of memory. Recent studies indicate that humans can voluntarily regulate awareness of unwanted memories by stopping the retrieval process that would ordinarily bring past experience into awareness. Event-related potential research on memory retrieval reveals that electrophysiological effects with specific timing and scalp topography serve as markers of memory processes. Previous studies showed that memory suppression affects the ERP correlates of conscious recollection. However, the temporal characteristics of the brain mechanism are not still fully understood. This systematic review examine the literature regarding EEG alterations in memory suppression, highlighting their results on electrophysiological indicators. A systematic review of EEG studies of memory suppression that reported EEG measures from January 2007 to February 2017 for which the PubMed, PsycINFO, Embase, and ScienceDirect databases were used. The literature search yielded 113 references, which 12 studies were eligible for inclusion. Quantitative EEG can be a simple and objective tool for studying the mechanisms involved in memory suppression. There is strong evidence that a parietal positivity around 400–800ms after cue presentation is an ERP marker of conscious recollection during memory retrieval and a larger N2 deflection during retrieval suppression predicted greater suppression-induced forgetting.

Key-words: ERP, EEG, Memory suppression, Inhibitory control, Think/no-think.

Introduction

One of the most relevant goals in the science of memory is understanding forgetting, which can be highly functional when the individual reminds of unpleasant even traumatic autobiographical experiences. To intentionally avoid and suppress particular mental representations is a powerful capability of the human mind/brain. There are many evidences that the ability of forgetting can be extend to the episodic memory domain (Anderson & Huddleston, 2011).

Over the past century, research involving the study of memory has focused on passive factors that make people forget, such as natural decay in memory traces. However, forgetting has been proposed as a result from the decay of memories over time, the accumulation of similar interfering experiences in memory, and changes in physical context that make it harder to recall the past (Anderson & Hanslmayr, 2014). Such emphasis on passive factors fits the common assumption that forgetting is a negative outcome and, thus, any process underlying it must happen involuntarily. The intentional suppression of unwanted memories may be a successful strategy to forget what we prefer not to think about (Anderson & Green, 2001).

Studies using the Think/No-Think paradigm indicate that it is possible to forget unwanted memories by repeatedly attempting to repress them (Anderson & Green, 2001; Anderson & Levy, 2009; Anderson & Huddleston, 2011). In this experimental approach, subjects learn paired associates and are subsequently presented with one member of those stimulus pairs (cue) and instructed to either suppress (no-think condition) or retrieve (think condition) the other member (target) of the pairs (Anderson & Green, 2001). In subsequent tests, memory for suppressed targets is lower when compared to baseline items that have been learned but not cued, before being either suppressed or retrieved between the study and test phases.

Suppression-induced forgetting has been a current target of study in the literature, with increasing knowledge about the phenomenon. First, forgetting increases with the number of times a memory is suppressed (Anderson & Green, 2001; Anderson & Huddleston, 2011), which indicates that suppression yields cumulative effects. Moreover, the forgetting effect can be increased if time is given to participants in order to prepare for suppression (Hanslmayr et al., 2010), indicating the importance of anticipatory processes. Also, suppression-induced forgetting arises with many stimuli, including word pairs, face–scene pairs (Depue et al., 2006), face–word pairs (Hanslmayr et al., 2009), word–object pairs (Gangepain et al., 2014)

and pairs comprising words and nonsense shapes (Hart & Schooler, 2012). Such process has even been observed for autobiographical experiences (Noreen & MacLeod, 2013), although suppression impairs memory for event details more than access to the event itself.

In sum, research indicates that humans are able to regulate awareness of unwanted memories by stopping the retrieval process that would expose past experience to awareness. Stopping retrieval in the presence of reminders may induce later forgetting of the refrained memory (Anderson & Green, 2001; Anderson et al., 2004; Depue et al., 2006, 2007), and engages a number of brain regions implicated in cognitive control, including lateral prefrontal cortex (LPFC) and anterior cingulate cortex (Anderson et al., 2004; Depue et al., 2007). However, hippocampal and visual representational activity (Anderson et al., 2004; Depue et al., 2007) and the magnitude of the event-related-potential (ERP) correlate of recollection (Bergström et al., 2007, 2009; Mecklinger et al., 2009) are reduced, indicating successful reduction of recollection.

The recruitment of inhibitory control areas in the prefrontal and parietal cortices is related to suppression of unwanted memories, and reduced retrieval-related activity it the hippocampus and sensory processing areas (Anderson et al., 2004; Depue et al., 2007; Butler & James, 2010; Dieler et al., 2010). Some fMRI studies suggest that voluntary memory suppression is the result of a dynamic relation between two systems: (1) A prefrontal control system that down-regulates (2) a distributed hippocampal/posterior cortical system, that stores memory traces and their sensory representations (Anderson & Hanslmayr, 2014; Anderson et al. 2004; Depue et al. 2007; Benoit & Anderson, 2012).

In measuring physiological responses correlate to cognitive and behavioral processes, the electroencephalogram (EEG) has a chief advantage of having a very high temporal resolution (in the order of milliseconds), which favors precise synchronization between stimuli presentation, behavioral responses and hypothesized rapid information processing stages. It is also simpler and less expensive to implement in clinics and laboratories, when were compared it with other central techniques, such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI). Moreover, contrast administration is not necessary, and claustrophobia is not an issue (Luck & Girelli, 1998). EEG has thus attracted great interest in studies seeking biomarkers in psychiatry (McLoughlin et al., 2014). Event-related potential (ERP) research on memory retrieval is now sufficiently advanced that particular ERP effects (defined by timing and scalp topography) can act as markers of memory processes (Rugg, 1995).

The main tool in real time examination of information processing employing EEG measurement are studies of Event-Related Potentials (ERPs). ERPs are synchronized activation of populations of neurons in response or preparation for events. That is, electrical potentials that are temporally associated with sensory, cognitive and motor events, and ERP components are peaks and valleys that oscillate in response to experimental manipulations (Rugg, 1995). Memory suppression was reflected in a series of negative amplitude peaks that predict later forgetting, a reduction of the recollection-related late parietal positivity, and a modulation of ERP slow-waves at anterior frontal electrodes (Bergström et al., 2009; Hanslmayr et al., 2009).

The fact that memory suppression affects the ERP correlates of conscious recollection, occurring around 500ms after onset of a memory cue was proven by previous Think/No-Think studies (Bergström et al., 2009; Mecklinger et al., 2009). This suggests that conscious retrieval is under strategic control and is able to intentionally be avoided during suppression attempts.

The main goal of this review is to study the literature regarding EEG alterations (Event-Related Potential Components) in memory suppression tasks, by analyzing articles that used the TNT paradigm, highlighting their results on electrophysiological indicators. It is important to consider that studies that aim at investigating the memory suppression have increased in number since its proposal. However, despite the variety of stimulus that are available to analyze the phenomenon trough Think/No-Think paradigm, the concept of the memory suppression is still new, and the temporal characteristics of the brain mechanism are not still fully understood.

Method

A systematic review of papers published from January 2007 to February 2017 was conducted, for which the PubMed, PsycINFO, Embase, and ScienceDirect databases were used. The search string “EEG” OR “electroencephalogram” OR “ERP” OR “event-related potential” AND “think/no-think” OR “memory suppression” OR “retrieval suppression” OR “intentional forgetting” was entered in the standard search field in all of the databases. In addition to these searches of electronic databases, manual searches were also performed using the reference sections of published texts to find articles that were eligible for inclusion. After removing duplicates, the articles were first assessed by seeking exclusion criteria in the title and abstract. The following exclusion criteria were adopted: (i) theoretical and review papers,

(ii) studies with clinical population and (iii) studies that did not use the think/no-think paradigm. Papers were initially selected according to their abstracts to identify the studies that effectively met the aims. The selection of papers and application of the exclusion criteria were performed by three independent judges. The three judges discussed again when discordances were observed until all three agreed. In case of discordances, a fourth judge was consulted. Once all of the studies that met the exclusion criteria were removed, the remaining papers were fully read to identify the tasks employed in the studies and the results. The experimental tasks were analyzed according to the subjects and type of task. The results were separated in two categories: ERP results and summary of EEG spectral analysis.

Results

After performing searches of the aforementioned databases and removing duplicates, 113 articles were obtained for review. Figure 1 shows the steps of the electronic search that led to 12 articles being included in the systematic review. The exclusions based on the title and abstract (n=63) were usually theoretical articles; articles that did not use TNT paradigm; studies with fMRI and publications in languages other than English. Of the remaining full-text articles, articles were excluded because of inclusion of psychiatric disorders (n=5) and a lack of EEG (n=6). The 12 studies selected are described below and grouped in two categories: event-related potential (ERP) studies and EEG spectral analysis studies.

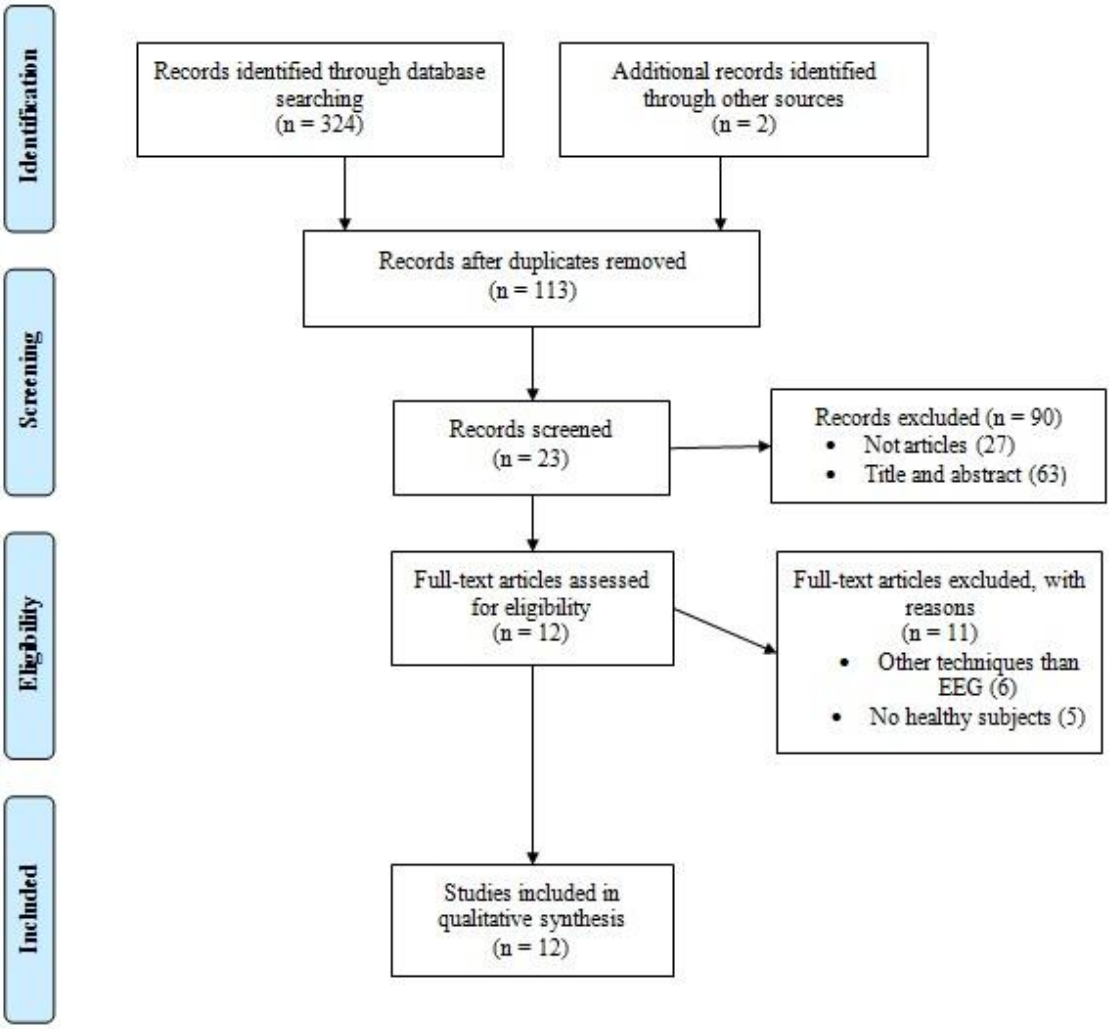

Figure 1. Summary of literature search, adapted from PRISMA (Moher e tal.,2009).

ERP results

The majority of the dimensional studies included in the review was comprised by ERP studies. There was twelve articles, nine of them were ERP studies and one performed both ERP and spectral analysis. The most common stimuli used in the ERP studies were word pairs. Table 1 describes the selected ERP studies. The results will be summarized below.

Table 1
Summary of ERP results

Study	Subjects	Task	Results
Waldhauser, Lindgren, & Johansson, 2012	22 healthy right-handed participants	TNT paradigm, 30 word pairs	More negative-going ERPs at frontal electrode sites for NT condition.
Depue et al., 2013	29 undergraduate students	TNT paradigm, 44 face–picture pairs	Overall increase of the parietal effect for T, as compared with NT and baseline trials.

Table 1 (continuance)
Summary of ERP results

Study	Subjects	Task	Results
Streb et al., 2016	21 healthy right-handed participants	TNT paradigm, 84 weakly related, neutrally valenced word pairs	The NT condition showed greater negative going ERPs at fronto-central electrode sites and an N2 component between 350 and 450ms over frontal and central electrodes.
Hellerstedt, Johansson, & Anderson, 2016	32 healthy right-handed participants	TNT paradigm, 96 semantically unrelated word pairs	A significantly greater negative slow wave (NSW) effect for intrusions compared with avoided retrievals in the 550–900ms. The LPP was attenuated during retrieval suppression.
Chen et al., 2012	20 healthy right-handed participants	TNT paradigm, 48 face-picture pairs	Memory suppression were associated with changes during a time window of 70–260 ms, such as P1 and N2, mainly at the right inferior frontal gyrus and occipital lobe.
Hanslmayr et al., 2009	24 healthy right-handed participants	TNT paradigm, 54 neutral faces and 54 semantically unrelated words	ERP effects were due to a decreased right frontal and left parietal positivity. Positivity in the NT condition was selectively reduced over right frontal and left parietal electrode sites.
Mecklinger, Parra, & Waldhauser, 2009	24 healthy participants	TNT paradigm, 70 weakly related word pairs	An early P2 component and a parietal positivity were related to retrieval attempts and a centro-parietal N2 component was associated with attempts to avoid memory retrieval. The parietal positivity was attenuated for NT trials on learned items. Stop signal N2 showed a similar centro-parietal scalp distribution as the N2 to NT trials.
Bergström, Fockert, & Richardson-Klavehn, 2009	21 participants in the Substitution group and 23 participants in the Suppression group	TNT paradigm, 36 weakly related word pairs	Only direct memory suppression reduced centro-parietal positivity in the event-related potentials (ERP) between 300 and 600ms post-stimulus. Only direct memory suppression produced later inhibitory forgetting that was predicted by an earlier negative. Thought substitution produced later non-inhibitory forgetting and had no effect on the ERP correlate of recollection.

ERP findings based on TNT task revealed significant differences between think (T) responses and memory suppression in no-think (NT) condition. Early and late slow wave components during NT trials were found across frontal (early) and parietal (late) electrodes. These components were highly correlated, suggesting a possible role of top–down frontal control over parietal regions during the TNT task.

Mecklinger, Parra and Waldhauser (2008) aimed at tracking the time course of control processes in the TNT phase by identifying further ERP correlates of control over memory retrieval. Twenty-four healthy participants learned weakly associated word pairs. An early P2 component and a parietal positivity were related to retrieval attempts and a centro-parietal N2 component was associated with attempts to avoid memory retrieval. The parietal positivity was attenuated for NT trials on learned items, for which item-specific memories exist. Also, a motor stopping experiment using a stop signal task was conducted with the same participants. Successful stopping was associated with an enhanced stop signal N2 that showed a similar centro-parietal scalp distribution as the aforementioned N2 to NT trials. Both components were significantly correlated.

Depue et al. (2013) found similar results regard to parietal positivity. The researchers conducted a study with 29 undergraduate students using face–picture pairs as stimuli. Their ERP findings support an overall increase of the parietal effect for T, as compared with NT and baseline trials. The suppression condition indicates reduced or down-modulated recollection processes during these trials.

Hanslmayr et al. (2009) searched for the existence of anticipatory processes, mediating such voluntary memory suppression and found some results in the same direction. Twenty-four healthy right handed volunteers participated of the study and were presented with neutral face-word pairs. ERP effects were due to a decreased right frontal and left parietal positivity. They were positively related and predicted later forgetting. The results point to the existence of anticipatory processes, mediating voluntary memory suppression. A T/NT repetition interaction analysis revealed that, compared with the T condition, positivity in the NT condition was selectively reduced over right frontal and left parietal electrode sites with increasing trial repetitions.

Another study (Bergstrom et al., 2007), with 23 participants that studied word pairs, found two significant ERP modulations that seem to reflect the strategic processing involved in voluntarily controlling recollection (an earlier ERP effect) and the effect this strategic processing has on actual recollection or avoidance of recollection of a stored item-specific memory (a later ERP effect). For the analysis, T and NT trials were separated on the basis of

previous learning success versus failure. This separation yielded temporal and topographic dissociations between early ERP effects of a T versus NT strategy, which were maximal between 200 and 300ms after stimulus presentation and independent of learning status, and a later learning-specific ERP effect maximal between 500 and 800ms after stimulus presentation. In this later time-window, learned Think items elicited a larger late left parietal positivity than did not learned Think, learned No-Think, and not learned No-Think items.

Waldhauser, Lindgre and Johanson (2012) performed a research with 22 participants that completed the TNT with word pairs as stimuli. To better analyze the results, time windows were selected based on previous findings, visual inspection of the data, continuous *t* -tests for each sampling point at all anterior/posterior electrode rows, and ERP peak detection at electrodes Fz and Pz. In the first time window (100–140ms) ERPs to T trials showed more negative amplitudes, with a main effect of T/NT. During the second time window (175–225ms) more negative-going wave forms to NT trials were observed that were most pronounced over centro-parietal electrodes. In the 300ms to 350ms time window, a negative ERP higher in amplitude for NT trials was obtained. Peaking between 450 and 500ms at right centro-parietal electrodes, another widespread negative-going ERP modulation was seen for NT items. Between 500 and 600ms were observed T/NT ×Anterior/posterior interaction, with more positive-going ERPs for T items over parietal electrodes. The only significant correlational pattern of ERP amplitude differences with later memory impairment was obtained between 300 and 350ms. Correlations were most pronounced across frontal, left hemispheric, and parietal electrodes.

Another study (Chen et al., 2012) investigated the time course of ERPs associated with suppression of negative and neutral memories using face-picture pairs as stimuli, with 20 healthy participants. ERPs and source analyses demonstrated that memory suppression processing for negative and neutral memories were generally associated with changes during early components of a time window of 70–260ms, such as P1 and N2, mainly at the right inferior frontal gyrus. Suppression of aversive memories was associated with two major late ERP components between 380 and 800ms, with significantly smaller later negativity (LN) but larger late parietal positivity (LPP), primarily at the right medial and superior frontal gyri.

A subsequent study of Bergstrom, Fockert and Richardson-Klaven (2009) directly contrasted thought substitution and direct suppression strategies for preventing memory retrieval, and measured later forgetting in order to determine whether the different strategies were associated with inhibitory or non-inhibitory forgetting. Twenty-four participants were randomly assigned to each group (suppression and substitution) and exposed to weakly

related word pairs. The results showed that only direct memory suppression reduced centro-parietal positivity in the event-related potentials (ERP) between 300 and 600ms post-stimulus, consistent with a reduction in the ERP correlate of recollection. Furthermore, only direct memory suppression produced later inhibitory forgetting that was predicted by an earlier negative ERP effect that may be associated with motor inhibition. In contrast, thought substitution produced later non-inhibitory forgetting and had no effect on the ERP correlate of recollection.

Hellersted, Johansson and Anderson (2016) study the ERP correlate of memory intrusion. They used the term memory intrusion to refer to retrievals that are not merely unintentional, but that are counter-intentional. That is, intrusions are memories that are retrieved, despite efforts to prevent retrieval from occurring, providing a clear operational definition of involuntary access. Thirty-two participants engaged in a TNT task with word pairs. The results indicated a significantly greater negative slow wave (NSW) effect for intrusions compared with avoided retrievals in the 550–900ms time window. This effect may be related to memory intrusions and has been related to working memory maintenance.

Finally, Streb et al. (2015) tested the hypothesis that individual differences in retrieval suppression predict intrusive memories after trauma, so 21 healthy participants watched a "traumatic" film after performing the TNT task. Grand average ERPs revealed pronounced differences between the T and NT conditions. The first ERP effect found consisted of an early negativity (200ms) that was larger in the NT condition than in the T condition. The early negativity to NT trials had abroad bilateral distribution and co-occurred with a positive (P2) deflection to T trials.

EEG spectral analysis results

A few works performed frequency domain analysis. Table 2 describes the selected spectral studies. Three studies employed time–frequency analysis in terms of oscillatory power and phase synchronization as measured by EEG, showing the dynamic oscillatory interaction of brain networks underlying voluntary memory suppression. The results of related frequency domain analysis will be summarized in this session.

The first study (Waldhauser, Bauml, & Hanslmayr, 2014) was conducted with 24 healthy human subjects which responded the TNT paradigm with pictures of faces with a neutral expression (as reminder stimuli) and semantically unrelated words (as targets). The results indicated that control effects were reflected in increased power in the theta (5–9 Hz) frequency band in the medial and dorsolateral prefrontal cortex and higher long-range alpha

(10–14 Hz) phase synchronization. In a decrease of theta oscillatory power in the medial temporal lobes, successful suppression of target memories was reflected and reduced long-range theta phase synchronization emerged after presentation of the reminder. This early increase in theta power was evident over frontal and parietal electrode sites and it was driven by a significant increase of theta power in the NT condition when compared with the T condition.

Table 2
Summary of EEG spectral analysis

Study	Subjects	Task	Results
Waldhauser, Bäuml, & Hanslmayr, 2014	24 healthy right-handed volunteers	TNT paradigm, 54 faces with a neutral expression semantically unrelated words	Control effects increased power in the theta (5–9 Hz) frequency band in the medial and dorsolateral prefrontal cortex and higher long-range alpha (10–14 Hz) phase synchronization
Ketz, O'Reilly, & Curran, 2014	30 healthy right-handedparticipants	TNT paradigm, 96 word–image pairs	Prominent theta oscillations (3 to 8 Hz) in controlled retrieval. Beta oscillations (12 to 30 Hz) were involved in high levels of both controlled retrieval and suppression
Depue et al., 2013	29 undergraduates	TNT paradigm, 44 female face–picture pairs	Increases in both alpha and theta power for NT as compared with T trials across parietal electrodes

However, the second research (Ketz, O´Reilly, & Curran, 2014) was conducted with 20 undergraduate students, which used face and scenes as stimulus. The comparison between controlled retrieval vs. controlled suppression indicated more prominent theta oscillations (3 to 8 Hz) in controlled retrieval. Beta oscillations (12 to 30 Hz) were involved in high levels of both controlled retrieval and suppression, that is an indication that it may have a more general control-related role.

Finally, in the third study the TNT paradigm was utilized using pairs of face with neutral expression and pictures negative in emotional content. EEG analyses indicated increased alpha (8–12 Hz) and theta (3–8 Hz) oscillations across parietal electrodes for items that were instructed to be suppressed versus those to be elaborated. Additionally, during the second half of the experiment (after repeated attempts at control), increases in theta oscillations were found across both frontal and parietal electrodes for items that were

instructed to be suppressed and that were ultimately forgotten versus those ultimately remembered. In sum, the oscillatory analyses revealed increases in both alpha and theta power for NT as compared with T trials across parietal electrodes.

Discussion

Quantitative EEG can be a simple and objective tool for studying the mechanisms involved in memory suppression. Regarding the studies included in this systematic review, some interesting findings were obtained to answer the question if there is an EEG pattern for memory suppression.

ERP studies

ERPs have been successfully employed in episodic memory tasks and can be used as markers of memory processes and the associated control mechanisms (Friedman & Johnson, 2000; Mecklinger & Jäger, 2009; Rugg & Wilding, 2000). As a technique with high temporal resolution, ERPs have been used to investigate neurocognitive processes underlying memory suppression with the TNT paradigm. Evidences from research in the field indicates that the correlate of recollection is a positive ERP at parietal regions, accentuated in the left hemisphere that extends from 400 to 800ms after stimulus onset (Friedman & Johnson, 2000; Mecklinger, 2000; Smith, 1993; Smith & Halgren, 1989). This positive component is larger for correctly recognized items from a previous learning phase than for correctly rejected new items.

There is strong evidence from previous studies that a parietal positivity around 400–800 ms after cue presentation is an ERP marker of conscious recollection during memory retrieval (Friedman & Johnson, 2000; Rugg, 1995; Rugg & Curran, 2007). Although this parietal EM effect typically has a focal left-lateralised parietal distribution in recognition tasks, it sometimes has a broad bilateral centro-parietal distribution, and perhaps particularly so in cued recall tasks (Allan & Rugg, 1997).

Several ERP components have been found to be related to memory suppression processing. First, early positive potentials, associated with attention to stimulus characteristics at visual processing stages (Smid, Jakob, & Heinze, 1999), was larger for T items than it was for NT(Bergstrom et al., 2007). Second, Bergstrom et al. (2007) found an early N2 component that emerged around 200ms post-stimulus was temporally similar to the No-Go-N2 potential. It was enhanced for NT items vs. T items and may be associated with inhibitory

activity (Anderson et al., 2004; Falkenstein, 2006; Wessel & Merckelbach, 2006). Finally, previous studies also reported a parietal episodic memory (EM) effect, which was reflected by a late parietal positivity (LPP) component emerging approximately 400–800ms after cue onset, which is noted to be associated with conscious recollection (Bergstrom et al., 2007; Mecklinger, 2000; Rugg, Woodruff, & Hayama, 2006; Rugg & Yonelinas, 2003).

The present review found some similar results as previous literature. The largest differences between T and NT trials emerged at frontal and central sites (Bergström et al., 2009; Mecklinger et al., 2009; Waldhauser et al., 2012; Streb et al., 2016; Hanslmayr et al., 2009). The results has shown that the parietal EM effect can be substantially reduced by voluntarily stopping retrieval (Bergström et al., 2009; Mecklinger et al., 2009; Hanslmayr et al., 2009).

There was found an electrophysiological correlate in several articles: a fronto-centrally distributed N2 component, a negative-going ERP component which is consistently larger during retrieval suppression than during retrieval (Bergström et al., 2009; Bergström et al., 2007; Depue et al., 2007; Mecklinger et al., 2009; Waldhauser et al., 2012; Chen et al., 2012; Streb et al, 2016). Importantly, a larger N2 deflection during retrieval suppression predicted greater suppression-induced forgetting (Mecklinger et al., 2009). A correlation has also been demonstrated between the TNT N2 and the N2 observed in a motor stopping task (Mecklinger et al., 2009; Bergstorm et al., 2009), suggesting that both processes recruit general response inhibition mechanisms. There is possible to assume that some of the systems recruited to override proponent motor responses are also involved to suppress memory retrieval.

Another important common result was a positive ERP at parietal regions. The overall increase of parietal effect for T condition between 300 and 600ms post-stimulus was related both in previous literature as in the present included articles (Friedman & Johnson, 2000; Bergstrom et al., 2009; Mecklinger et al., 2009; Depue et al., 2013, Streb et al., 2016, Hanslmayr et al., 2009). Those finds indicates that there is a pattern from a ERP marker of conscious recollection during memory retrieval.

In summary, the results demonstrate an electrophysiological dissociation between ERP correlates of task-related strategic processes and the ERP correlate of item-specific conscious recollection versus avoidance of recollection. The most consistent findings include centro-parietal positivity in the ERP between 300 and 600ms post-stimulus, consistent with a reduction in the ERP correlate of recollection, and a larger N2 component deflection during suppression, that emerged around 200ms post-stimulus, involved in control systems. Although the data presented here indicates a pattern in the ERP correlates of memory

suppression, it is important to note that participant instructions and strategies to stop retrieval were not reported with details in most papers.

EEG spectral analysis studies

In intracranial recordings, neural oscillations measure fluctuations in the local field potential and this reflects the excitatory and inhibitory input into different neuronal assemblies (Buzsaki & Draguhn, 2004). However, in the EEG, these control mechanisms are evident in increased frontal theta oscillatory activity, that has been localized to medial and lateral prefrontal cortex regions during response conflict (Hanslmayr et al. 2008), memory interference (Staudigl et al., 2010), and memory suppression (Depue et al., 2013).

Top-down cognitive control in general and memory suppression rely on enhanced fronto-parietal communication too (Corbetta & Shulman, 2002; Paz-Alonso et al., 2013), which is reflected in increased phase synchronization in the alpha frequency band (Sauseng et al., 2005; Sadaghiani et al., 2012).If they are taken together, these findings suggest that memory suppression should partially be mediated by increased prefrontal theta (5–9 Hz) oscillatory power and higher phase coupling in the alpha (10–14 Hz) band.

Increased oscillatory power in the theta frequency band is commonly associated with successful memory retrieval (Nyhus & Curran, 2010).Increased phase synchronization in the theta band, which appears to be generated by hippocampo-cortical feedback loops is also a characteristic of retrieval and memory maintenance (Cashdollar et al., 2009).

Increased in theta frequency correlated with successful retrieval in all analyzed studies. Two of the three results (Depue et al., 2013; Waldhauser, Bauml, & Hanslmayr, 2014) also found a increased oscillatory power in the alpha frequency. Those results are consistent with previous literature and evidence, corroborating that the findings that memory suppression should be mediated by increased prefrontal theta oscillatory power and higher phase combination in the alpha band. However, it is important to note that the sample presented is small and more studies are needed to confirm the pattern of the findings.

Conclusions

In summary, the present systematic review results highlight the promising potential of centro-parietal positivity in the ERP between 300 and 600ms post-stimulus as an important correlate of recollection, and a larger N2component deflection around 200ms post-stimulus during suppression, as a important correlate involved in control systems. Theta and alpha

measures also are suggests to act as potential biomarkers of memory suppression. However, there is more work needed to confirm if these EEG parameters are effective as a pattern from aERP marker of conscious recollection during memory retrieval.

Limitations

One limitation of the present systematic review concerns the use of three electronic databases, even though they are the principal databases used in the field. Moreover, the search was limited to articles published in English. Consequently, this review provides no information regarding unpublished studies or studies published in other languages. The search was restricted to articles published since 2007. Another limitation was the heterogeneity of the studies, which made it impossible to perform a meta-analysis. The conclusions are based on a qualitative analysis of the studies. Future studies should try to include similar variables, whenever possible, to allow for greater comparability of findings.

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CAPÍTULO II

To think or not to think: ERP correlates of memory suppression and substitution

Abstract

There are some past experiences that we would prefer not to remember. Previous research indicates that humans are able to voluntarily control awareness of unwanted memories through the act of stopping the retrieval process that would ordinarily bring past experience into awareness. Stopping retrieval in the presence of reminders can cause later forgetting of the avoided memory, and engages a number of brain regions implicated in cognitive control. However, the mechanisms of preventing memory retrieval, and how these relate to the later forgetting, are yet to be fully understood. The main goal of this study is to present neural and behavioral evidence for two distinct strategies for retrieval stopping – direct memory suppression and self-distracting thought substitution – that contribute to forgetting of unwanted memories in qualitatively different ways. Only direct memory suppression reduced centro-parietal positivity in the event-related potentials (ERP) between 300 and 600ms post-stimulus, consistent with a reduction in the ERP correlate of recollection. Because the late left parietal positivity indexes conscious recollection, the results provide evidence that conscious recollection of information can be voluntarily avoided on and help to clarify previous neural evidence from the Think/No-Think procedure.

Key-words: ERP, Memory suppression, Inhibitory control, Think/no-think, Retrieval stopping.

Introduction

Since Ebbinghaus (1885), forgetting has been an important and long-standing topic in psychological research. In memory research, forgetting has been traditionally treated as a memory failure that results from passive processes. From another perspective, intentional forgetting can be characterized as a strategic function of the cognitive system that allows us not to think about unwanted memories from our past, as for example emotional events or traumatic experiences that we would prefer not to remember. In that sense, intentional forgetting as an active cognitive process could be referred to as our ability to control the retrieval of unwanted memories (Mecklinger, Parra, & Waldhauser, 2008).

In order to have access only to relevant information, voluntary process are able to guide memory retrieval. The capacity to stop the retrieval of irrelevant information is an important aspect of controlled memory retrieval and some researchers assume that this form of control is supported by inhibitory mechanisms (Anderson, 2005; Mecklinger, Parra, & Waldhauser, 2008).

There are a few possibilities that keep us from been controlled by habitual actions, such as inhibition of undesired actions. Recent studies indicates that humans are able to voluntarily control awareness of unwanted memories through the act of stopping the retrieval process that would ordinarily bring past experience into awareness. Stopping retrieval in the presence of reminders can cause later forgetting of the avoided memory (Anderson & Green, 2001; Anderson et al., 2004; Depue et al., 2006, 2007), and engages a number of brain regions implicated in cognitive control. However, the mechanisms of preventing memory retrieval, and how these relate to the later forgetting, are yet to be fully understood.

In sum, forgetting can be highly functional when being reminded of unpleasant or even traumatic autobiographical experiences. Studies employing the Think/No-Think paradigm show that it is possible to forget unwanted memories by repeatedly attempting to suppress them (Anderson & Green, 2001;Anderson et al., 2004; Anderson & Levy, 2009; Anderson & Huddleston, 2011).

To understand how people stop retrieval, Anderson and Green (2001) developed a procedure modeled after the go/no-go task, which is a paradigm designed to investigate motor stopping. In an usual Go/No-Go paradigm, participants press a button as fast as possible whenever they see a letter appear on a screen, except when the letter is an X, for which they must not press the button (Miller et al., 1991). The inhibitory control over action is measured by their ability to retain the response. In order to see if stopping retrieval also engages

inhibitory control, Anderson and Green (2001) adapted this procedure to develop the ‘‘Think/No-Think’’ (TNT) paradigm.

The TNT paradigm is as an experimental procedure that reproduces situations in which people ignore a memory that they prefer not to think about and try to keep it out of mind. Participants study cue–target word pairs (e.g., clock–lion), and are trained to recall the second word (lion) whenever they encounter the first word (clock) as a reminder. Then, participants are asked to exert control over retrieval during the experimental Think/No-Think phase. Most trials require them to remember the response whenever they see the reminder (think trials); however, for some reminders, participants are advised to avoid retrieving the response (no-think trials). It is essential to recognize that it is insufficient to avoid saying the response, because they must prevent the memory from entering awareness. Therefore, participants must stop the cognitive act of retrieval. Then, think and no-think trials are given either 0, 1, 8, or 16 times. In the final cued recall test, the subjects' memory is tested for the response words in two conditions (Anderson & Green, 2001).

The general finding from the results is a linear decline of retrieval for suppressed items (no-think trials). This memory impairment indicates/implies that inhibitory control may be voluntarily recruited to prevent unwanted memories from coming to mind. This large difference, known as the total control effect, demonstrates that is possible that intention to control retrieval modulates later memory (Anderson & Green, 2001; Anderson et al., 2004).

Neural mechanisms of motivated forgetting

Using functional magnetic resonance imaging (fMRI), Anderson et al. (2004) investigated the brain region involved in the afore mentioned effects. They found a network of brain regions showing greater activation during no-think trials than during think trials, including bilateral dorsolateral and ventrolateral prefrontal regions, the anterior cingulate cortex, and several premotor areas. This increased activation of prefrontal areas during suppression has been interpreted as a brain correlate of an active executive process that inhibits an unwanted memory. Also, a bilaterally reduction of hippocampus activation was obtained for no-think trials relative to think trials, indicating that the amount of recollection is reduced in no-think, i.e. when subjects attempt to prevent the associated word from entering consciousness at all (Anderson et al., 2004; Anderson & Hanslmayr, 2014; Depue et al. 2007; Benoit & Anderson, 2012).

The lateral prefrontal cortex and anterior cingulate cortex areas seem to form a network that overlaps strongly with the one involved in motor inhibition tasks (such as

Go/No-Go), even though no motor responses were required (Bergström et al., 2009; Hanslmayr et al., 2009). The lateral prefrontal cortex, in particular, plays a critical role in stopping reflexive motor responses (Aron, Fletcher, Bullmore, Sahakian, & Robbins, 2003). In fact, stimulation of this region during a ‘‘go’’ motor response induces monkeys to stop their movement (Sasaki, Gemba, & Tsujimoto, 1989). This overlap suggests that stopping unwanted actions and unwanted memories engages a common neural system.

The hippocampus is essential in order to form episodic memories (Squire, 1992). Increased hippocampal activation has been linked to consciously recollecting an event. Considering that suppressing an unwanted memory requires that people stop retrieval to prevent conscious recollection, the hippocampal activity is reduced when participants suppress retrieval compared to when they retrieve a memory, suggesting that people can intentionally regulate hippocampal activation to disengage recollection (Anderson et al., 2004).

Recently, Depue et al. (2007) replicated the activation of the motor stopping network and the down-regulation of the hippocampus during no-think trials when people suppressed retrieval of aversive scenes. They also found that suppression reduced activation in the amygdala, a structure implicated in emotion processing. This may be understood as a suppressing recollection of unpleasant memories that can also limit negative emotional responses, consistent with the involvement of memory suppression in emotion regulation. Importantly, during no-think trials, hippocampus and amygdala were not only less engaged than they were during think trials, but they were also less active than they were when people just stared passively at an empty screen, which means that overriding retrieval involves actively disengaging these brain regions (Depue et al., 2007).

A failing of the fMRI study is that this technique is not able to track the time course of the brain mechanism (engaged by the attempts to forget or remember items in the think/no-think phase), due its low temporal resolution. Electrophysiological measures of brain activity produce similar conclusions. Memory suppression was reflected in a series of negative amplitude peaks that predict later forgetting, a reduction of the recollection-related late parietal positivity, and a modulation of ERP slow-waves at anterior frontal electrodes in event-related potentials (ERPs) research (Bergström et al., 2009; Hanslmayr et al., 2009).

The fact that memory suppression affects the ERP correlates of conscious recollection, occurring around 500ms after onset of a memory cue was proven by previous Think/No-Think studies (Bergström et al., 2009; Mecklinger et al., 2009). This suggests that conscious retrieval is under strategic control and is able to intentionally be avoided during suppression

attempts. However, Bergstrom, Fockert and Richardson-Klavehn (2009) understood that individual differences in memory suppression were predicted by the size of an early negative ERP effect which likens one associated with performing a ‘‘no-go’’ task and that can be originated in the lateral prefrontal cortex. In this way, behavioral measures of executive control, such as complex working-memory span, predict memory suppression (Anderson& Levy, 2009).

The ERP correlate of recollection is a positive ERP at parietal regions, accentuated in the left hemisphere that extends from 400 to 800ms after stimulus onset (Friedman &Johnson, 2000; Mecklinger, 2000;Smith, 1993; Smith & Halgren, 1989). This positive component is bigger for correctly recognized items from a previous learning phase than for correctly rejected new items.

ERPs have been successfully employed in episodic memory tasks and can be used as markers of memory processes and the associated control mechanisms (Friedman & Johnson, 2000; Mecklinger & Jäger, 2009; Rugg & Wilding, 2000). Nevertheless, although supportive of the direct suppression account, a lot of studies did not report the participants strategies for preventing retrieval. There are many different ways in which people can attempt to stop a memory from coming to mind and there are reasons to believe that different strategies for preventing retrieval are associated with qualitatively different mechanisms of forgetting (Bergstrom et al., 2009).

Strategies for preventing retrieval

The mechanisms underlying retrieval stopping and the consequent later forgetting nevertheless remain unclear. The most common ways that people prevent to stop memory retrieval, direct suppression and thought substitution, must be distinguished. Direct suppression may be distinguished from thought substitution, which instead involves generating substitute memories or thoughts to distract oneself, and so actively engages the retrieval process (Bergstrom et al., 2009). Direct suppression instructions specifically ask participants to not retrieve distracting thoughts and to purge memories from awareness if they intrude, effectively asking participants to shut down all retrieval in response to cues. Although both instructions led to similar forgetting, the neural mechanisms underlying them have been separated. Whereas thought substitution engaged left ventrolateral prefrontal cortex to retrieve substitute memories, and its activation predicted increased retrieval-related activity in the hippocampus, effective connectivity analysis indicated that direct suppression recruited right dorsolateral prefrontal cortex to down-regulate hippocampal activity and inhibit conscious

recollection (Benoit & Anderson, 2012). Thus, direct suppression instructions are thought to better isolate inhibitory control processes acting on hippocampally mediated traces than general no-think instructions, which may include some component of thought substitution (Benoit & Anderson, 2012; Gagnepain et al., 2014).

Stopping memory retrieval has been hypothesized to rely on the same neurocognitive system that is involved in stopping preprotent motor responses (Anderson et al., 2004; Levy & Anderson, 2008). It was predicted that if memory inhibition is a consequence of stopping retrieval using this response-override system, individual differences in No-Think ERP N2 magnitude should predict individual differences in subsequent memory impairments on the final recall tests too, lined up to previous fMRI research (Anderson et al., 2004).

Considering the distinction between direct suppression and thought substitution has only recently been investigated, the majority of the current literature has employed general, unguided task instructions, remaining unclear which were the strategies instructions and pattern used. ERPs have some considerable advantages over fMRI, in that they can separate strategic and item-specific processes in real time during an experimental trial.

The current study

The main goal of the present study is to examine the temporal characteristics of the brain mechanism initiated by Think and No-Think trials, using event-related potential (ERP) measures, in two different strategies to prevent retrieval: Direct memory suppression and self-distracting thought substitution

The current research manipulated participant strategies for stopping memory retrieval and measured ERPs at the time such retrieval stopping occurred, in order to investigate the neurocognitive mechanisms that contribute to the forgetting of unwanted memories. The TNT paradigm (Anderson & Green, 2001) were applied with neutral word-pairs. The neutral stimuli was selected to clearly establish that any observed deficit reflects a general difficulty with inhibitory control over memory, and not a problem in disengaging from emotional material.

Strategies for preventing memory retrieval were contrasted through thought substitution and direct suppression. The specific task design followed a prior fMRI study (Anderson et al., 2004), but, in this current experiment, retrieval stopping instructions were additionally manipulated across two groups. Both groups were told to avoid thinking of the no-think responses at all times. On one hand, in the substitution group, people were asked to

self-distract generating substitute associations to the no-think reminders in order to prevent the original memory from coming to mind. On the other hand, in the suppression group, people were asked to not think of anything else while stopping the no-think responses from coming to mind.

In order to distinguish memory suppression and thought substitution at the time these strategies for stopping retrieval occurred, ERPs were measured during the Think/No-Think phase to see if these strategies for retrieval stopping have distinguishable electrophysiological signatures or if these putative distinct signatures have different correlates in terms of later forgetting.

Expected results for current experiment were: a) a recollection performance significantly higher in the "think" condition when compared to "baseline". At the same time, the recall in the "no-think" condition should be significantly lower, compared to the "baseline"; b) in relation to electrophysiological markers, only a strategy of memory suppression should present an increase of ERP correlated to memory recollection, that is, greater centro-parietal positivity for the "think" condition; c) the N2 component, correlated with the motor response, should present greater deflection in subjects who used the strategy of memory suppression and d) if distinct mechanisms underlie retrieval stopping depending on strategy, qualitative differences in neural activity should emerge between the two participant groups.

Methods

Participants

Eleven native Portuguese (Brazil) speakers (ages 18–40) participated in each group (Suppression: mean age 26.3, 6males; Substitution: mean age 28.3, 6 males), with participants being randomly assigned to groups. All participants gave written informed consent and the experiment was approved by the Federal University of Rio Grande do Sul Psychology Department Ethical Committee in compliance with national legislation. Prior to their inclusion in the study, all participants had normal or corrected to normal vision, including normal color vision. No participant reported any history of neurological disease. Selection was non-probabilistic and conducted by convenience from the general population through advertising with visual material on the university campus and social media. Exclusion criteria were (1) severe depression symptoms or suicidal ideation (BDI-II Total score greater than 29;

score ≥ 1 on Item 9, respectively); (2) reported historical of learning disorder; (3) presence of psychotic symptoms; and (4) left-handed or ambidextrous.

Materials and Procedure

The procedure for this experiment is depicted in Figure 1. Stimulus presentation was done using E-Prime v1.1 software(Psychology Software Tools, Pittsburgh, PA).

The tasks, including stimuli and trial-timings, were kept as similar as possible to those used in a previous fMRI study (Anderson et al., 2004). Participants were first exposed to 36 weakly related experimental word pairs, 12 each in the think, no-think, and baseline conditions. The words were selected from the translation and adaption of the Affective Norms for English Words (Bradley & Lang, 1999) to Brazilian Portuguese (Kristensen et al., 2011),weakly related and neutrally valenced.

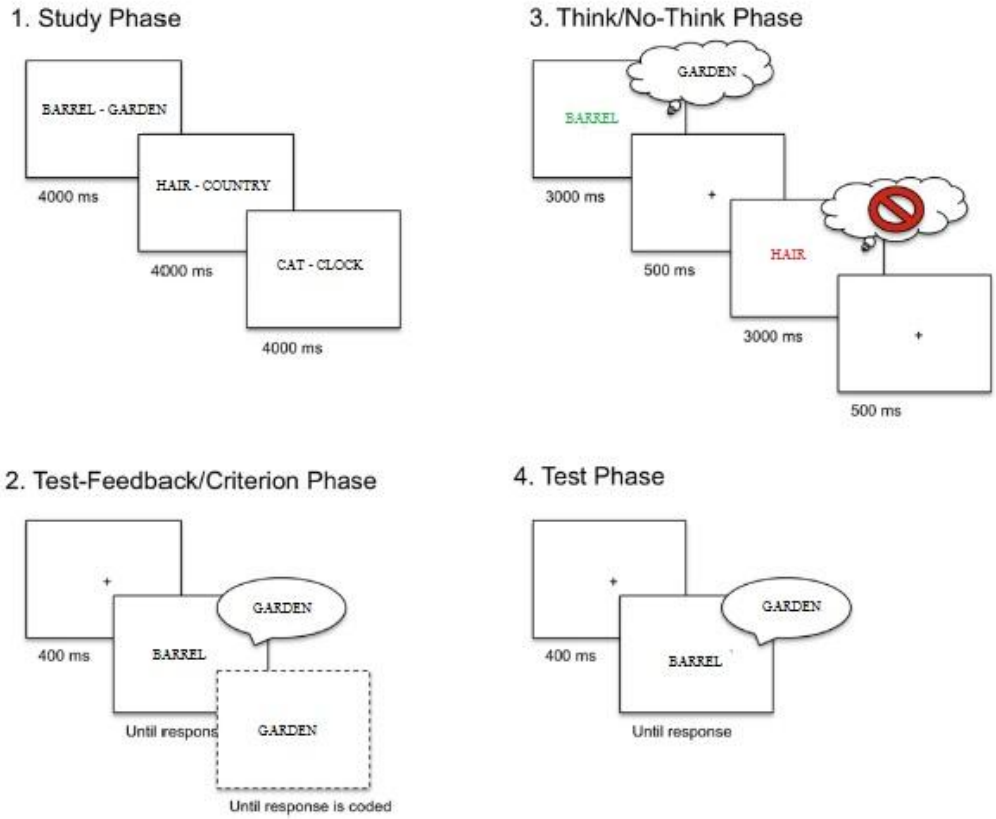


Figure 1. Experimental procedure.
Participants first learned the word pairs in the study phase, after which they practiced retrieving the target word aloud when presented with the cue for each pair. Once participants reached at least 50% performance in the test-feedback phase, they go to the Think/No-Think (TNT) phase. For think items (in green), participants retrieved the associated target. For no-think items (in red), they were asked to not remember the target. Following the TNT phase participants completed the test phase, in which they were presented with each cue word and were instructed to recall the corresponding target aloud.

Participants studied each word pair for 4s after which they practiced retrieving the target word when presented with the cue for each pair. During this phase, each cue appeared one at a time in the center of the screen (preceded by a 400ms fixation) and remained until participants produced the associate out loud. The correct target was presented 400ms later and remained on screen until the experimenter pressed a button to code for response accuracy. Participants were instructed to use the appearance of the target as an opportunity to better learn the cue-target pairs. This process was continued until a threshold of 50% accuracy was achieved or until the phase was repeated thrice.

Next, think and no-think cue-words were repeatedly presented 16 times each (randomly interspersed within lists) whereas baseline cue-words were not presented. The colour of the cue-words signified the think and no-think conditions. For green cue-words (the think condition), participants were instructed to immediately think of the response word and keep it in mind the entire time that the cue was on the screen. For red cue-words (the no-think condition) they should still read the cue-word and pay full attention to it, but they must to keep the response word out of consciousness for the entire trial. Each cue word was presented for 3s, after which a fixation cross appeared for 500ms.The fixed presentation order for each block was created pseudo-randomly with the constraints that (i) there were no more than 3 consecutive cues of the same color, and (ii) a given cue could only be repeated once all other cues had been presented within a block.

The crucial No-Think strategy manipulation was accomplished by varying the no-think instructions between groups as follows. The thought substitution group was told: “You should accomplish the blocking of the response word by trying to replace it with other thoughts, such as the hint word's associations with words different from the one you are blocking. To repeat: try thinking of other words associated with the cue word in order to block the response, as well as keep paying attention to, and looking at, the cue word the entire time”. In order to maintain ecological validity with the type of thought substitute strategies that people might use in real life situations, there was no control of the content of the substitute thoughts. The memory suppression group was told: “You should accomplish this by trying to block thinking of the response word, but not by replacing it with any other thoughts. To repeat: do not think of anything else than the cue word while you are blocking the response, just keep paying attention to, and looking at, the cue word the entire time”. Verbal and written instructions were given to all participants.

Finally, participants were once again tested for all word pairs. On each trial, a single cue word was and participants were instructed to recall the relevant target word out loud. No feedback was given and responses were recorded and scored by the researcher.

Electrophysiological recording e preprocessing

EEG was recorded from 24 Ag/AgCl scalp electrodes embedded in a Mitsar EEG 202 system (Saint Petersburg, Russia) and referenced to linked mastoids. Midline electrode locations were Fz, Cz, and Pz, and left and right hemisphere sites were Fp1/Fp2, F3/F4, F7/F8, C3/C4, T3/T4, P3/P4,T5/T6, and O1/O2 . Signals were amplified with a bandwidth of 0.1 to 30 Hz using a Mitsar amplifier, at a sampling rate of 250 Hz. Electrode scalp impedances were kept below 5 kΩ. Acquired data were analyzed using EEGLAB 13.6.5b (Delorme &Makeig, 2004) and ERPLAB 6.0 (Lopez-Calderon & Luck, 2014), two open source toolboxes for EEG and ERP analysis in MATLAB (MathWorks, Inc, Natick, MA). The continuous EEG data were filtered digitally with a high-pass of 0.1 Hz and a low-pass of 30 Hz. Continuous data was separated into epochs ranging from-200ms to 800ms locked to cue onset. ERPs were formed for the two conditions Think/No-Think. Artifacts were removed using ERPLAB's Moving window Peak-to-Peak algorithm with a threshold 112 μV starting at 100 ms post stimulus until 800ms in each epoch, participant that had more than 50% of epochs with artifacts were excluded from the analysis.

Next, ERPs were formed for the conditions in each group timelocked to the onset of the cue-words, including only items that participants had successfully learned prior to the Think/No-Think phase. The aim of only including demonstrably learned items in the ERPs was to increase the signal-to-noise ratio for the neural processes causative of forgetting that occurred during the Think/No-Think phase, i.e. neural differences related to forgetting that were direct consequences of the Think/No-Think and Strategy manipulations. The logic behind this analysis was that any strategic effects initiated by the Think and No-Think cues should be present irrespective of prior learning success or failure. Conversely, ERP correlates of successful retrieval or retrieval avoidance should only be present for words that are retrievable in principle, i.e. those that were initially learned in the study phase. As cue words were presented 16 times with either Think and No-Think instruction, the ERPs for both conditions were averaged across these repetitions of cue words. The analyses of the forgotten Think ERPs was not presented.

Because the experiment specifically addressed the neurocognitive mechanisms of inhibitory and non-inhibitory forgetting, the primary ERP effects of interest were those that related to subsequent memory. Hence, the main analysis focused on these effects.

ERP statistical analyses

The main ERP statistical analysis was conducted using SPSS 18. A Repeated Measures ANOVA with the factors Condition (think, no-think) x Strategy group (Suppression, Substitution) and mean amplitude (in micro voltages) for selected electrode as dependent variable was conducted for each of the time windows described as follows. Visual inspection of the Grand Averages were conducted and yielded separate time windows for ERP analysis. Moreover, times windows according to the literature were also analyzed. The grand average ERPs for the no-think and think condition derived from all word pairs of the test phase are depicted at the three midline electrodes, Fz, Cz and Pz plus F3, F4, P3 and P4.

The time windows selected for statistical analysis given the parameters discussed above were, among the two group conditions (Suppression and Substitution): For F3 and F4 (i) from 200ms until 300ms; and (ii) from 300ms until 400ms; for Fz, Cz and Pz from 228ms until 276ms; and for P3 and P4 from 452ms until 724ms.

Results

Behavioral results

Table 1 shows behavioral results for participants included in the ERP sample(nine participants in the Suppression group and eleven in the Substitution group). Two participants that had more than 50% of epochs with artifacts were excluded from the analysis. Final recall test are expressed as means and standards deviations of the numbers of item recalled for condition in both strategies.

Table 1
Means and standard deviations for words recalled per condition

	Suppression (n= 9)		Substitution (n=11)	
	M	SD	M	SD
Think	10	1.5	8.9	2.54
No-Think	7	2.54	7.1	2.21
Baseline	9.1	1.6	8	2.14

A priori planned comparisons on the basis of prior research that has typically found significant no-think impairments (Anderson & Green, 2001; Anderson et al., 2004) revealed that no-think recall was significantly lower than baseline recall for both groups (Suppression: t (8.2)=2.5, p< .001; Substitution t (10.6)=2.2, p< .001).

To investigate the full data pattern, a two-way ANOVA with the factors Strategy (Suppression vs. Substitution)× TNT (Think vs. No-Think vs. Baseline) condition was performed. The results revealed a significant main effect of TNT (z (14.9), p<.001, Greenhouse-Geisser corrected), but there was no significant strategy group effect or TNT and strategy group interaction.

Thus, direct suppression instructions resulted in impaired recall for no-think items, consistent with inhibition. By contrast, thought substitution instructions caused a no-think impairment, which is more consistent with non-inhibitory accounts of forgetting.

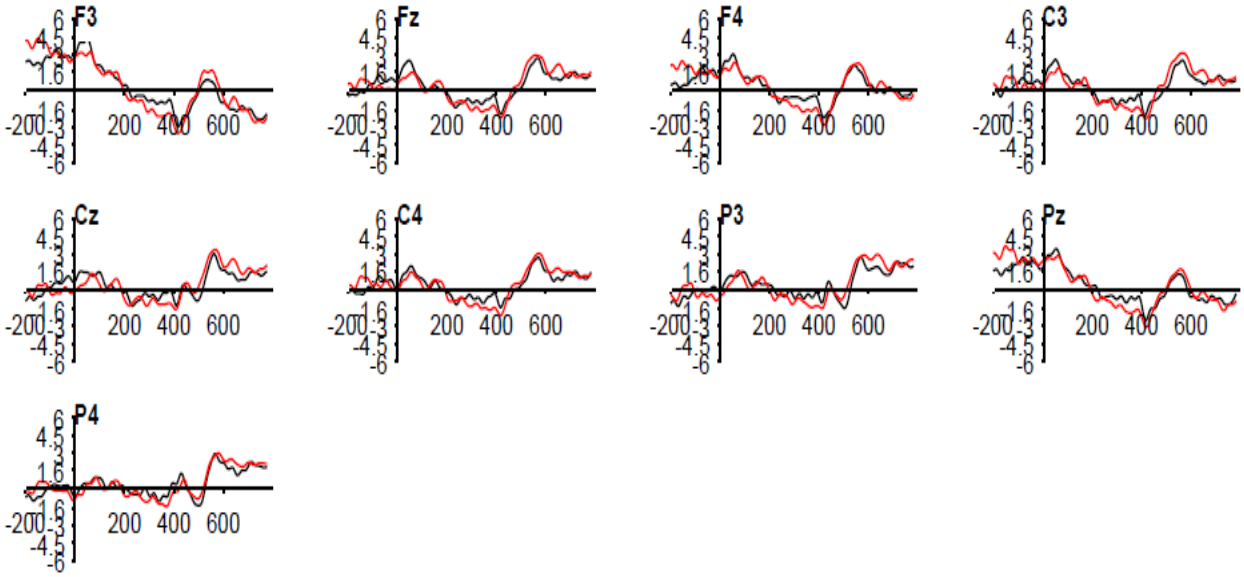
ERP results

Grand average ERPs (Figure 1) show some similarities between the two strategies for retrieval stopping, but also striking differences. The suppression group strategy produced an early, task-related, ERP effect which consisted of an enhanced early (~200ms) negative deflection of the ERPs (henceforth termed the early negativity effect) in the no-think condition compared to think condition in Fz electrode (Fig. 2). The early negativity effect showed greater magnitude in the Suppression compared to the Substitution group. However, these results did not reaches statistical significances. The effect for condition (Think x No-Think) was F(1,18)=0,962, p=0,340; the interaction for condition and group F(1,18)=2,864, p=0,108; and the effect for group F(1,18)=0,713, p=0,410. The most reliable differences occurred between 200 and 300ms post-stimulus, when anterior sites showed more positive ERPs for the two think than the two no-think conditions.

In the 452–724ms time window, a think>no-think pattern was obtained at P3 electrode, showing a significant effect for condition (think x no think) F(1,18)=4,515, p<0,05 (Fig. 3). Think items elicited reliably more positive ERP amplitudes than the other conditions at left parietal sites, maximal between around 450ms and 700ms post-stimulus.

The principal results revealed two significant ERP modulations that seem, respectively, to reflect the strategic processing involved in voluntarily controlling recollection (an earlier ERP effect) and the effect this strategic processing has on actual recollection or avoidance of recollection of a stored item-specific memory (a later ERP effect). These modulations were experimentally, topographically, and temporally separable.

A



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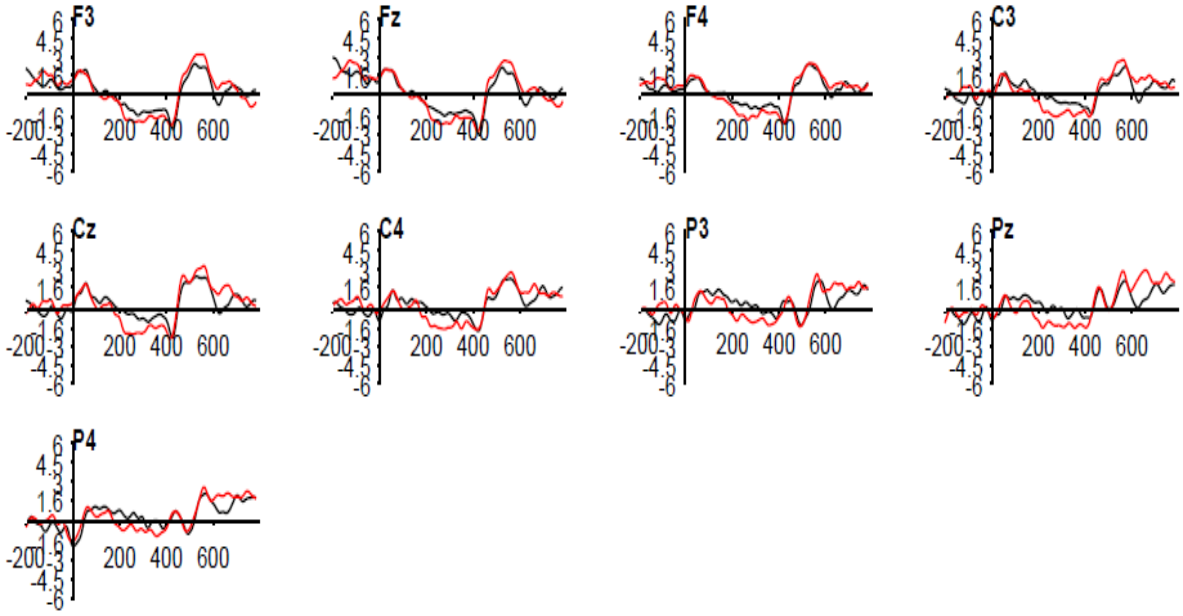


BIN1: No Think

BIN2: Think

A: Suppression Group

B: Substution Group

Figure 1. Grand average ERPs for the two strategy groups.

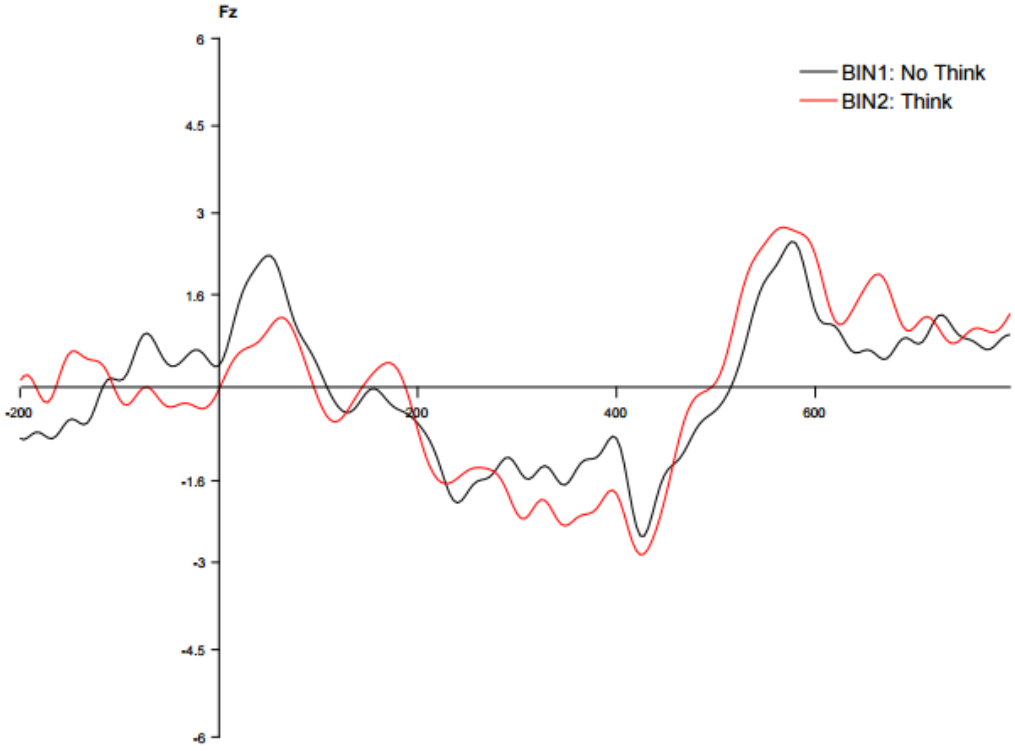
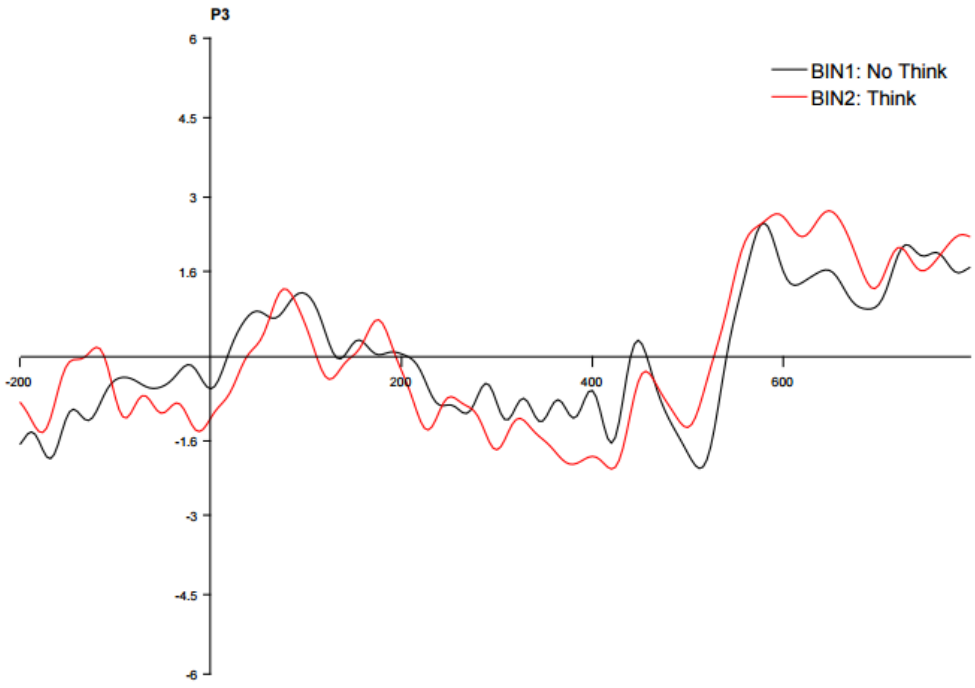


Figure 2. Grand average ERP for Suppression group at frontal (Fz) sites. The effect is visually observed in the interval between 200 and 300ms.

A



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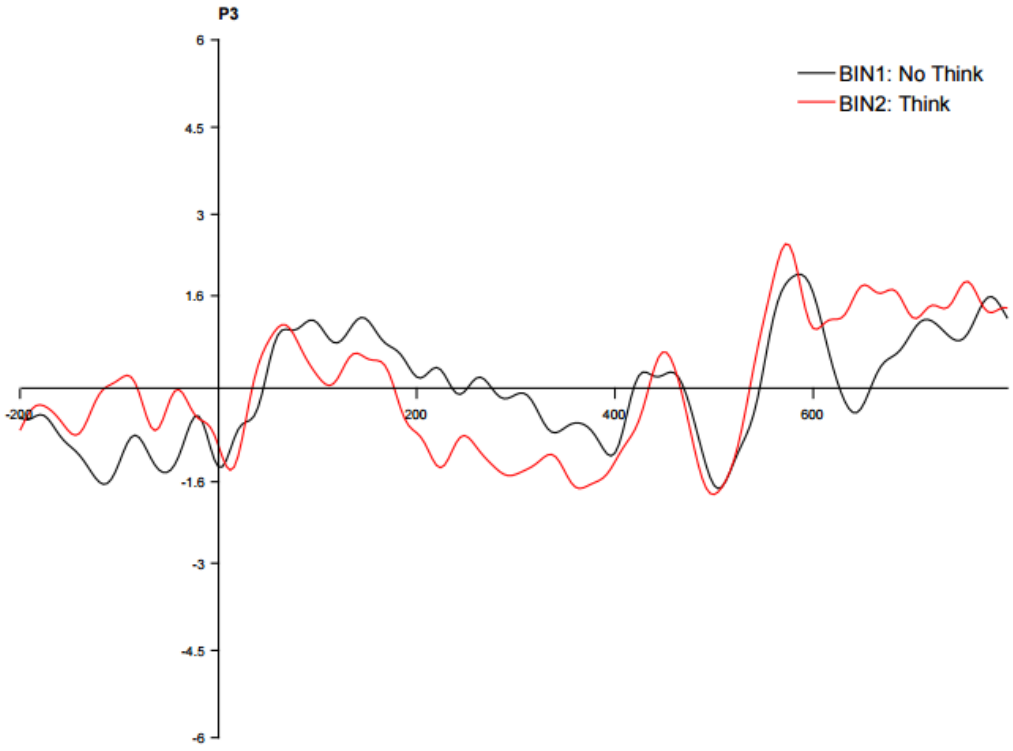

Figure 3. Grand average ERPs for two strategies groups at left parietal sites (P3). The effect is visually observed in the interval between 450 and 700ms.

Discussion

Anderson et al. (2004) previously found that instructing participants to avoid recollection of previously studied material produced a reduced hemodynamic response in the hippocampus and other recollection-related brain areas compared with instructing participants to recollect the material. This finding is interpreted as neural evidence of voluntary avoidance of conscious recollection, at the time such avoidance occurred. However, Anderson et al. (2004) previous fMRI design did not permit for a distinction between the neural correlates of the strategy of recalling or avoiding recollection of the items, and did not permit to identify the neural correlates of item-specific recollection versus avoidance of recollection. The current experiment employed ERPs, which have a much higher time resolution than fMRI, and analyzed the ERPs on the basis of learning status including just the learned think and no-think conditions.

It is known that ERPs have been successfully employed in episodic memory tasks and can be used as markers of memory processes and the associated control mechanisms

(Friedman & Johnson, 2000; Mecklinger & Jäger, 2009). As a technique with high temporal resolution, ERPs have been used to investigate neurocognitive processes underlying memory suppression with the TNT paradigm. Evidences from research in the field indicates that the correlate of recollection is a positive ERP at parietal regions, accentuated in the left hemisphere that extends from 400 to 800ms after stimulus onset (Friedman & Johnson, 2000; Mecklinger, 2000; Smith, 1993). This positive component is larger for correctly recognized items from a previous learning phase.

A parietal positivity around 400–800ms after cue presentation is an ERP marker of conscious recollection during memory retrieval (Friedman & Johnson, 2000; Rugg,1995; Rugg& Curran, 2007). Although this parietal EM effect typically has a focal left-lateralised parietal distribution in recognition tasks, it sometimes has a broad bilateral centro-parietal distribution, and perhaps particularly so in cued recall tasks (Allan & Rugg, 1997). The parietal amplitude reduction is most likely a consequence of successful suppression, representing reduced recollection-related activity for suppressed memories in the hippocampal-parietal network (Anderson et al., 2004; Depue et al., 2007).

The current study found that the nature of the later ERP modulation was consistent with the notion that item-specific recollection of recollectable information can be voluntarily avoided: the left parietal episodic memory effect, which indexes conscious recollection (Rugg et al., 1996), was observed when participants were trying to recollect learned items, but not when they were trying to avoid recollection of learned items.

The present study found a pattern as described above: Think items elicited reliably more positive ERP amplitudes than the other condition at left parietal P3 electrode, indicating a important marker of conscious recollection. The results showed that only direct memory suppression reduced centro-parietal positivity in the event-related potentials (ERP) between 450 and 700ms post-stimulus, consistent with a reduction in the ERP correlate of recollection.

Furthermore, only direct memory suppression produced later inhibitory forgetting that was predicted by an earlier negative ERP effect that may be associated with motor inhibition, even it was not significant effect it is possible to see different patterns in ERP grand averages, comparing the two strategies. In contrast, thought substitution produced later non-inhibitory forgetting and had no effect on the ERP correlate of recollection. However, the early no-think negativity emerged slightly earlier and was of smaller magnitude than the typical motor inhibition N2. It was also earlier than the 350–450ms no-think negativity that was identified by Mecklinger et al. (2009) as correlated with motor inhibition N2s. In fact, the later fronto-centrally (Fz electrode) distributed negativity that predicted item forgetting in the Suppression

group, in the current experiment was more similar to the no-think negativity in data presented by Mecklinger et al. (2009). The current ERP results indicated a evidence of the time course of these processes, suggesting that this neural system for inhibitory forgetting begins to act as early as around 200ms after presentation of a reminder of an unwanted memory.

The findings presented here dissociate inhibitory and non-inhibitory forgetting on tasks in which all external parameters are the same except for task instructions, and provide strong, bringing more evidence to understand how direct suppression works in human memory. In this account of memory inhibition, unwanted memories can be directly targeted and suppressed by cognitive control mechanisms, without the need to facilitate alternative associations to supplant the original memory (Anderson &Green, 2001; Anderson et al., 2004; Depue et al., 2007).

In sum, the current research provides behavioral and ERP evidence of separable inhibitory and non-inhibitory mechanisms that contribute to stopping retrieval of memories. Furthermore, the results suggest that memories can be suppressed by cognitive control mechanisms, which may involve a general neurocognitive system for overriding unwanted acts, whether covert acts such as memory retrieval.

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CONSIDERAÇÕES FINAIS

Pesquisas atuais demonstraram que é possível esquecer intencionalmente conteúdos que foram previamente aprendidos (Anderson & Hanslmayr, 2014; Waldhauser, Bauml, & Hanslmayr, 2014; Anderson & Green, 2001). Tal esquecimento intencional pode desempenhar uma função estratégica no sistema cognitivo. (Macklinger, Parra, & Waldhauser, 2008). Entretanto, existem diversas maneiras pelas quais as pessoas podem tentar impedir que uma memória venha à mente e os mecanismos subjacentes à parada da recuperação de memória e o conseqüente esquecimento posterior todavia permanecem pouco claros. Deste modo, a presente dissertação teve por objetivo geral investigar os mecanismos neurocognitivos que contribuem para o esquecimento de memórias.

Estudos recentes utilizaram correlatos de potenciais relacionados a eventos (ERPs) como evidências para a capacidade de suprimir memórias indesejáveis. Achados prévios da literatura indicam que a supressão da memória reduz a positividade centro-parietal nos ERPs entre 400 e 800ms pós-estímulo, consistente com uma redução no ERP correlacionado à recuperação, uma vez que é um marcador de lembrança consciente durante a recuperação da memória. Além disso, outro importante correlato eletrofisiológico encontrado em tarefas que demandam supressão de estímulos foi o componente N2, o qual mostrou maior deflexão durante a supressão da recuperação do que durante a recuperação. Essa deflexão na expressão do componente N2 prediz melhor eficácia no esquecimento induzido pela supressão (Friedman & Johnson, 2000; Rugg, 1995; Rugg & Curran, 2007; Bergstrom et al., 2009; Mecklinger et al., 2009).

Os resultados decorrentes da presente dissertação corroboram com dados relatados na literatura da área. O primeiro estudo, uma revisão sistemática da literatura, indicou que a positividade parietal, em torno de 400-800ms após a apresentação do estímulo, mostrou-se um padrão de marcador de lembrança consciente durante a recuperação de memória nos artigos empíricos analisados. Também, demonstrou-se fortes evidências de que uma maior deflexão no componente N2 durante a supressão, em torno de 200ms após apresentação do estímulo, é um preditor de esquecimento induzido. Em suma, os resultados provenientes da revisão sistemática sugerem que a positividade centro-parietal, a deflexão do componente N2 e as medidas nas oscilações *Theta* e *Alpha* agem como importantes biomarcadores de supressão de memória.

O ensaio empírico teve como principal objetivo investigar a partir do paradigma *Think/No-Think* (Anderson & Green, 2001) as características temporais dos mecanismos

cerebrais eliciados nas condições *Think* e *No-Think*, isto é, na recordação e no esquecimento induzido, em duas estratégias distintas de esquecimento: A supressão de memórias e a substituição de pensamentos. Os resultados decorrentes deste estudo estão congruentes com os achados da literatura, indicando que é possível mapear o sistema cognitivo subjacente à supressão de memórias.

O estudo empírico indicou um importante padrão: Os resultados mostraram que apenas a supressão da memória reduziu a positividade centro-parietal nos potenciais relacionados a eventos (ERP) entre 450 e 700ms pós-estímulo, consistente com uma redução no correlato ERP de lembrança.Os resultados sugerem que as memórias podem ser suprimidas por mecanismos de controle cognitivo, indicando a existência de um padrão neurocognitivo na ação de suprimir informações indesejáveis da recuperação de memória.

A presente dissertação fornece fortes evidências, tanto da literatura atual quanto do experimento empírico,para uma melhor compreensão sobre como a supressão de memórias funciona na mente humana. Estudos vêm demonstrando que evitar a recuperação de memórias indesejáveis aumenta a probabilidade de que essas memórias sejam esquecidas posteriormente (Bergstorm et al., 2009; Anderson et al., 2004). Deste modo, a manipulação experimental aqui proposta apresenta resultados sobre os mecanismos de controle inibitório sobre a memória que podem ser relevantes para futuros ensaios clínicos.

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Bergström, Z.M., de Fockert, J. W. & Richardson-Klavehn, A. (2009). ERP and behavioural evidence for direct suppression of unwanted memories. *NeuroImage, 48,* 726- 737.

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ANEXOS

ANEXO A - Aprovação da pesquisa pelo Comitê de Ética do Instituto de Psicologia da Universidade Federal do Rio Grande do Sul

INSTITUTO DE PSICOLOGIA - UFRGS

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Pensar ou não pensar: Potenciais corticais na supressão de memória indesejada e ruminação

Pesquisador: Gustavo Gauer

Área Temática:

Versão: 2

CAAE: 55797216.1.0000.5334

Instituição Proponente: Instituto de Psicologia - UFRGS

Patrocinador Principal: MINISTERIO DA CIENCIA, TECNOLOGIA E INOVACAO

DADOS DO PARECER

Número do Parecer: 1.638.356

Apresentação do Projeto:

O presente trabalho pretende investigar a capacidade humana de suprimir memórias indesejadas e a sua correlação com ruminação e controle de pensamentos, utilizando-se de marcadores eletrofisiológicos de eletroencefalografia (EEG). Serão realizados dois estudos, sendo o primeiro uma revisão sistemática da literatura e o segundo um estudo empírico. O estudo empírico contará com 60 participantes, que realizarão uma atividade experimental composta pelo paradigma Think/ No-think desenvolvido por Anderson e Green (2005). Durante a totalidade da tarefa os participantes terão o registro de EEG continuamente gravado. Caracterizada como uma pesquisa quantitativa exploratória, trata-se de um estudo quase-experimental. Composto por um delineamento fatorial 3 x 2, sendo um fator intra-sujeito com três níveis (condição think, no -think, baseline) e um fator inter-sujeitos com dois níveis (estratégia de supressão de memória e estratégia de substituição de pensamentos). Cada participante será designado aleatoriamente a um de dois grupos,

que responderá à tarefa utilizando a estratégia de supressão ou substituição de memória.

Objetivo da Pesquisa:

Objetivo Primário:

O presente projeto pretende investigar o efeito da supressão de memórias e sua relação com

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Bairro: Santa Cecília **CEP:** 90.035-003
UF: RS **Município:** PORTO ALEGRE
Telefone: (51)3308-5698 **Fax:** (51)3308-5698 **E-mail:** cep-psico@ufrgs.br

ruminação, buscando avaliar se a ruminação está associada com déficit no controle mnemônico.

Objetivo Secundário:

Objetiva-se ainda, mapear os Potenciais relacionados a eventos (ERPs) eliciados durante o experimento nas condições think, no-think e baseline, em duas estratégias distintas para impedir a recuperação de memória: a supressão de memória e a auto-distração por substituição de pensamentos.

O estudo também visa a buscar se há correlação na capacidade dos indivíduos de supressão e na auto percepção da habilidade de controlar pensamentos.

Avaliação dos Riscos e Benefícios:

Riscos:

Há a possibilidade de o participante se sentir cansado(a) devido ao tempo que o experimento demandará. O principal risco associado ao experimento se deve ao desconforto devido à calibração do equipamento e à sua duração. Todo equipamento será mostrado e explicado a fim de diminuir qualquer sentimento de desconforto. Embora seja bastante improvável, o gel condutor pode manifestar uma reação alérgica. Nesse caso, o participante será acompanhado até o hospital e receberá os procedimentos médicos necessários. Caso haja qualquer inconformidade com alguma situação da tarefa ou no caso de necessidade, o participante será devidamente encaminhado para serviços de atendimento psicológico. Por este procedimento já vir sendo usado em numerosos estudos sem a descrição de ocorrência de qualquer prejuízo aos participantes, entende-se que o risco é inferior aos benefícios que os participantes possam vir a obter. Durante o experimento os dados do eletroencefalograma serão continuamente registrados. Trata-se de um procedimento não-invasivo, sem nenhum risco significativo. No caso de eventuais danos não previstos, será disponibilizada assistência imediata e integral, sendo realizados encaminhamentos para acompanhamento profissional. Haverá ressarcimento em caso de danos ou gastos não previstos.

Benefícios:

A participação contribuirá em muito para o conhecimento científico sobre como pessoas suprimem memórias. O participante auxiliará na compreensão de como os indivíduos são capazes de suprimir ou substituir recordações, bem como a sua relação com ruminação de pensamentos. Também, contribuirá na compreensão de quais componentes eletrofisiológicos estão presentes no fenômeno de supressão, clarificando melhor como se dá o funcionamento mnemônico.

Toda pesquisa com seres humanos envolve risco em tipos e gradações variados. Não indicam

riscos nem benefícios diretos, no entanto apontam os cuidados para minimizá-los e a proteção oferecida aos participantes.

Atende as orientações da RESOLUÇÃO Nº 466, DE 12 DE DEZEMBRO DE 2012.

Comentários e Considerações sobre a Pesquisa:

Trata-se de projeto de dissertação do Programa de Pós-Graduação em Psicologia. O projeto não passou por avaliação da COMPESQ, no entanto, foi aprovado no dia 18 de março de 2016, por banca examinadora composta pelos Professores Lisiane Bizarro Araujo (UFRGS), Giovanni Abrahão Salum Júnior (UFRGS), Christian Haag Kristensen (PUCRS). A ata foi lavrada pela Coordenadora do Programa de Pós-Graduação Profa. Denise Ruschel Bandeira, conforme documento anexado na Plataforma Brasil.

Considerações sobre os Termos de apresentação obrigatória:

Atende as orientações da RESOLUÇÃO Nº 466, de 12 de dezembro de 2012.

Conclusões ou Pendências e Lista de Inadequações:

Não há pendências e ou inadequações.

Considerações Finais a critério do CEP:

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB INFORMACÕES BÁSICAS DO PROJETO 701451.pdf	26/05/2016 22:46:22		Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	tclenovo.pdf	26/05/2016 22:45:25	CAMILA ARGUELLO DUTRA	Aceito
Projeto Detalhado / Brochura Investigador	projetodissertacaocamiladutra.pdf	26/05/2016 22:42:44	CAMILA ARGUELLO DUTRA	Aceito
Outros	parecer.pdf	27/04/2016 21:45:10	CAMILA ARGUELLO DUTRA	Aceito
Projeto Detalhado / Brochura Investigador	projetocamilaarquellodutra.pdf	27/04/2016 21:44:09	CAMILA ARGUELLO DUTRA	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	tclecep.pdf	27/04/2016 21:42:57	CAMILA ARGUELLO DUTRA	Aceito

Folha de Rosto	folhaderostocep.pdf	27/04/2016 21:41:12	CAMILA ARGUELLO DUTRA	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

PORTO ALEGRE, 15 de Junho de 2016

Assinado por: Clarissa Marcell Trentini (Coordenador)

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UF: RS **Município:** PORTO ALEGRE
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ANEXO B – Termo de Consentimento Livre e Esclarecido

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

DADOS DE IDENTIFICAÇÃO DO PARTICIPANTE

PARTICIPANTE: .....

SEXO: ..... DATA NASCIMENTO: ...../...../.....

CIDADE: ..... TELEFONE: (.....) .....

EMAIL: .....

DADOS SOBRE A PESQUISA

1. Título da Pesquisa: Pensar ou não pensar: Potenciais corticais na supressão de memória indesejada e ruminação

2. Pesquisadora responsável: Dr. Gustavo Gauer (Professor do Instituto de Psicologia da Universidade Federal do Rio Grande do Sul)

Pesquisador executante: Camila Arguello Dutra (Mestranda do Programa de Pós-Graduação em Psicologia da Universidade Federal do Rio Grande do Sul)

3. Avaliação do risco da pesquisa: MÍNIMO ⊟ BAIXO □ MÉDIO □ MAIOR □

4. **Duração da pesquisa:** A duração total deste projeto é prevista para 9 meses, mas você só precisará participar hoje.

5. Justificativa e objetivo:O presente estudo pretende investigar o efeito da supressão de memórias e sua relação com ruminação, buscando avaliar se a ruminação está associada com déficit no controle mnemônico.

6. Procedimentos: A fase pré-experimental será composta por: perguntas pessoais iniciais, preenchimento de escalas, instruções sobre o experimento,fase de prática e esclarecimento de dúvidas. Em seguida o experimento será iniciado. Você visualizará pares de palavras com valência emocional neutra e será instruído a recordá-las ou não. A sua memória será testada para todas as palavras apresentadas e você será orientado a utilizar uma estratégia para impedir a recordação da palavra associada à pista. Durante o experimento você terá dados do Eletroencefalograma continuamente registrados, trata-se de um procedimento não-invasivo. Espera-se uma duração total de aproximadamente uma hora e 30 minutos.

7. Riscos e inconveniências: Há a possibilidade de você se sentir cansado(a) devido ao tempo que o experimento demandará. Caso haja qualquer inconformidade com alguma situação da tarefa ou no caso de

necessidade, você será devidamente encaminhado para serviços de atendimento psicológico. Por este procedimento já vir sendo usado em numerosos estudos sem a descrição de ocorrência de qualquer prejuízo aos participantes, entende-se que o risco é inferior aos benefícios que os participantes possam vir a obter.

8. Potenciais benefícios: Os benefícios da sua participação serão a contribuição para a Ciência, especialmente para o desenvolvimento da área de supressão de memórias e regulação emocional.

Como participante da pesquisa, você terá assegurados os seguintes direitos:

a) **Garantia do uso dos dados coletados apenas para o objetivo deste estudo:** Os dados que você dará serão utilizados somente para os objetivos dessa pesquisa.

b) **Sigilo e privacidade:** As informações que você dará (os questionários preenchidos) serão mantidas em lugar seguro e os participantes não serão identificados. A identificação só poderá ser realizada pelo pessoal envolvido diretamente com o projeto. Caso o material venha a ser utilizado para publicação científica ou atividades didáticas, não serão utilizados nomes que possam identificá-lo.

c) **Direito a informação**: Em qualquer momento você poderá obter mais informações com o **Prof. Dr.GustavoGauer**ou com a pesquisadora mestranda **Camila Arguello Dutra,** pelos respectivos telefones (51)3008-5341 e (51)9671-0977; pelos e-mails gusgauer@gmail.com e camiladutra.psico@gmail.com; ou presencialmente na Rua Ramiro Barcelos, 2600, 1º andar, sala 121, Porto Alegre - RS, Brasil. Eles estarão aptos a esclarecer suas dúvidas. Você também poderá solicitar informações de qualquer conhecimento significativo descoberto durante este projeto.

d) **Direito de informação sobre aspectos éticos da pesquisa:** Se você tiver alguma consideração ou dúvida sobre a ética da pesquisa, entre em contato com o Comitê de Ética em Pesquisa do Instituto de Psicologia da Universidade Federal do Rio Grande do Sul (Rua Ramiro Barcelos, 2600 – Porto Alegre/RS) presencialmente ou pelo telefone (51)3308-5698.

e) **Despesas e compensações**: Não há nenhum valor econômico a receber ou a pagar pela sua participação. No entanto, caso você tenha qualquer despesa decorrente da participação na pesquisa, haverá ressarcimento em dinheiro. De igual maneira, caso ocorra algum dano decorrente de sua participação no estudo, você será devidamente indenizado, conforme determina a lei.

f) **Direito a não participar ou interromper sua participação no estudo**: Você tem liberdade para se recusar a participar ou retirar seu consentimento em qualquer momento da pesquisa, s alização alguma e sem prejuízo para você.

g) **Garantia de assistência**: Você será devidamente informado acerca de encaminhamento para locais de assistência à saúde (unidades básicas de saúde, clínicas-escola e clínicas particulares) caso assim deseje ou caso seja necessário.

h) **Via do presente Termo de Consentimento Livre e Esclarecido**: Serão elaboradas duas vias do presente Termo de Consentimento, as quais serão rubricadas em todas as suas páginas e assinadas, ao seu término, por você ou por seu representante legal, assim como pelo pesquisador responsável, ou pela(s) pessoa(s) por ele delegada(s), devendo as páginas de assinaturas estar na mesma folha. Certifique-se de ter recebido uma via. Isso é um direito seu.

_____

Acredito ter sido suficientemente informado a respeito das informações que li ou que foram lidas para mim, descrevendo o estudo: "Pensar ou não pensar: Potenciais corticais na supressão de memória indesejada e ruminação". Concordo voluntariamente com a minha participação e poderei retirar o meu consentimento a qualquer momento, antes ou durante o mesmo, sem penalidades ou prejuízo.

_____

Assinatura do participante

Data ____/___/_____

_____

Assinatura do responsável pelo estudo

Data ____/___/_____

Esse termo possui duas vias de igual teor (idênticas): uma para posse do participante e outra para os pesquisadores (a ser devolvida assinada pelo participante).

ANEXO C – Questionário de Dados Sociodemográficos

A partir de agora você irá responder a um questionário sociodemográfico e de saúde geral.

Q1 Sexo:

- Feminino
- Masculino

Q2 Idade: ____

Q3 Lateralidade manual:

- Destro
- Canhoto
- Ambidestro

Q4 Você possui problemas visuais não corrigidos?

- Sim
- Não

Q5 Você sofre de daltonismo?

- Sim
- Não

Q6 Raça:

- Caucasiano(a)
- Negro(a)
- Amarelo(a)
- Pardo(a)
- Outro _____

Q7 Estado civil:

- Solteiro(a)
- Casado(a)
- Separado(a)
- Divorciado(a)
- Viúvo(a)
- União estável
- Outro _____

Q8 Nível de instrução:

- Ensino fundamental incompleto
- Ensino fundamental completo

- Ensino médio incompleto
- Ensino médio completo
- Ensino superior incompleto
- Ensino superior completo
- Pós-graduação lato senso incompleta
- Pós-graduação lato senso completa
- Mestrado incompleto
- Mestrado completo
- Doutorado incompleto
- Doutorado completo
- Pós-doutorado incompleto
- Pós-doutorado completo

Q9 O que você cursa ou cursou na pós-graduação? _____

Q10 Curso de graduação:
_____

Q11 Situação ocupacional:

- Estudante
- Estudante (bolsista)
- Profissional liberal
- Empregado com carteira assinada
- Empregado sem carteira assinada
- Funcionário público
- Autônomo
- Do lar
- Sem atividade remunerada
- Outro _____

Q12 Nacionalidade:

- Brasileira
- Outra _____

Q13 Em que cidade você nasceu? _____

Q14 UF: _____

Q15 Em que cidade você residiu maior parte da sua vida? _____

Q16 Onde você mora?

Rua: _____ Nº:_____
Complemento:_____CEP:_____ Bairro: _____ Cidade:
_____ UF:_____

Q17 Renda individual: _____

Q18 Renda familiar:_____

Q19 Quantas pessoas vivem dessa renda? _____

Q20 Religião: _____

Q21 Pratica essa religião?

- Sim
- Não

Q22 Usa alguma medicação atualmente, incluindo psicofármacos?

Q23 Qual(is)? _____

Q24 Dose(s)? _____

Q25 Há quanto tempo? _____

Q26 Já realizou ou realiza algum tipo de tratamento psiquiátrico ou psicológico?

- Sim, realizo.
- Sim, realizei.
- Não.

Q27 Qual(is)? _____

Q28 Fumante?

- Sim
- Não
- Fumo raramente
- Outro _____

Q29 Você ingere bebidas alcoólicas com que frequência?

- Não bebo.
- Uma ou duas vezes ao ano.
- Uma ou duas vezes a cada seis meses.
- Uma ou duas vezes a cada três meses.
- Uma ou duas vezes por mês.
- Uma vez por semana.
- Duas vezes por semana.
- Três vezes por semana.
- Quatro ou cinco vezes por semana.
- Diariamente.
- Outro _____

Q30 Nos últimos 12 meses, em três ou mais ocasiões você bebeu pelo menos cinco latas de cerveja ou uma garrafa de vinho ou três doses de uma bebida alcoólica forte (pinga, caipirinha, conhaque, vodca, uísque...), num período de três horas?

- Sim
- Não

Q31 Quanto à sua ingestão de álcool:

Você já pensou em largar a bebida?	Sim	Não
Ficou aborrecido quando outras pessoas criticaram seu hábito de beber?	Sim	Não
Se sentiu mal ou culpado pelo fato de beber?	Sim	Não
Bebeu pela manhã para ficar mais calmo ou se livrar de uma ressaca (abrir os olhos)?	Sim	Não

Q32 Você ingeriu álcool ou consumiu alguma outra droga hoje?

- Sim
- Não

Q33 A que horas, o que e qual a quantidade?

_____
_____
_

Q34 Hoje em dia você faz uso de alguma droga, mesmo que ocasionalmente?

- Sim
- Não

Q35 Qual(is)?

Q36 Quantidade:

Q37 Periodicidade:

- Diariamente
- De 4 a 6 dias por semana
- De 2 a 3 dias por semana
- 1 vez por semana
- 2 ou 3 vezes ao mês
- 1 vez ao mês
- 1 vez a cada 3 meses
- 1 vez a cada 6 meses
- 1 vez ao ano
- Outro _____

Q38 Você usou drogas no passado?

- Sim
- Não

Q39 Qual(is)? _____

Q40 Quantidade:

Q41 Periodicidade:

- Diariamente
- De 4 a 6 dias por semana
- De 2 a 3 dias por semana
- 1 vez por semana
- 2 ou 3 vezes ao mês
- 1 vez ao mês
- 1 vez a cada 3 meses
- 1 vez a cada 6 meses
- 1 vez ao ano
- Outro _____

Q42 Você ingeriu alguma bebida à base de cafeína hoje?

- Sim
- Não

Q43 Se sim:

Q44 Quantidade? _____

Q45 Há quanto tempo? _____

Q46 Há quanto tempo você se alimentou pela última vez? _____

Q47 Você está se sentindo cansado ou com sono agora?

- Sim
- Não

Q48 Você possui algum transtorno neurológico?

- Não.
- Não sei, mas acho que não.
- Não sei, mas acho que sim.
- Sim.
- Outro _____

Q49 Qual(is)? _____

Q50 Atualmente, você sofre de algum transtorno psiquiátrico?

- Não
- Suspeito que sim.
- Sim.
- Outro _____

Q51 Qual(is)? _____

Q52 Você toma alguma medicação ou realiza algum tipo de terapia/tratamento para isso?

- Sim, estou medicado.
- Sim, faço terapia.
- Sim, estou medicado e faço terapia.
- Não.

Q53 Se você tiver interesse em realizar algum tipo de tratamento para seu transtorno, por favor, deixe seu e-mail que lhe indicaremos locais que prestam serviços de saúde.

_____

Muito obrigada por participar da nossa pesquisa!

ANEXO D– Inventário de Depressão Beck

BDI

Data:___/___/_____

Nome:_____ Estado Civil:_____ Idade:_____ Sexo:_____

Ocupação:_____ Escolaridade:_____

Este questionário consiste em 21 grupos de afirmações. Depois de ler cuidadosamente cada grupo, faça um círculo em torno do número (0, 1, 2 ou 3) próximo à afirmação, em cada grupo, que descreve **melhor** a maneira que você tem se sentido na **última semana, incluindo hoje**. Se várias afirmações num grupo parecerem se aplicar igualmente bem, faça um círculo em cada uma. **Tome o cuidado de ler todas as afirmações, em cada grupo, antes de fazer a sua escolha.**

1
0 Não me sinto triste.
1 Eu me sinto triste.
2 Estou sempre triste e não consigo sair disto.
3 Estou tão triste ou infeliz que não consigo suportar.

2
0 Não estou especialmente desanimado quanto ao futuro.
1 Eu me sinto desanimado quanto ao futuro.
2 Acho que nada tenho a esperar.
3 Acho o futuro sem esperança e tenho a impressão de que as coisas não podem melhorar.

3
0 Não me sinto um fracasso.
1 Acho que fracassei mais do que uma pessoa comum.
2 Quando olho para trás, na minha vida, tudo o que posso ver é um monte de fracassos.
3 Acho que, como pessoa, sou um completo fracasso.

4
0 Tenho tanto prazer em tudo como antes.
1 Não sinto mais prazer nas coisas como antes.
2 Não encontro um prazer real em mais nada.
3 Estou insatisfeito ou aborrecido com tudo.

5
0 Não me sinto especialmente culpado.
1 Eu me sinto culpado grande parte do tempo.
2 Eu me sinto culpado na maior parte do tempo.
3 Eu me sinto sempre culpado.

6
0 Não acho que esteja sendo punido.
1 Acho que posso ser punido.
2 Creio que vou ser punido.
3 Acho que estou sendo punido.

7
0 Não me sinto decepcionado comigo mesmo.
1 Estou decepcionado comigo mesmo.
2 Estou enojado de mim.
3 Eu me odeio.

8
0 Não me sinto de qualquer modo pior que os outros.
1 Sou crítico em relação a mim por minhas fraquezas ou erros.
2 Eu me culpo sempre por minhas falhas.
3 Eu me culpo por tudo de mal que acontece.

9
0 Não tenho quaisquer idéias de me matar.
1 Tenho idéias de me matar, mas não as executaria.
2 Gostaria de me matar.
3 Eu me mataria se tivesse oportunidade.

10
0 Não choro mais que o habitual.
1 Choro mais agora do que costumava.
2 Agora, choro o tempo todo.
3 Costumava ser capaz de chorar, mas agora não consigo, mesmo que o queira.

11
0 Não sou mais irritado agora do que já fui.
1 Fico aborrecido ou irritado mais facilmente do que costumava.
2 Agora, eu me sinto irritado o tempo todo.
3 Não me irrito mais com coisas que costumavam me irritar.

12
0 Não perdi o interesse pelas outras pessoas.
1 Estou menos interessado pelas outras pessoas do que costumava estar.
2 Perdi a maior parte do meu interesse pelas outra pessoas.
3 Perdi todo o interesse pelas outras pessoas.

13
0 Tomo decisões tão bem quanto antes.
1 Adio as tomadas de decisões mais do que costumava.
2 Tenho mais dificuldades de tomar decisões do que antes.
3 Absolutamente não consigo mais tomar decisões.

_____ Subtotal da Página 1 **CONTINUAÇÃO NO VERSO**

14
0 Não acho que de qualquer modo pareço pior do que antes.
1 Estou preocupado em estar parecendo velho ou sem atrativo.
2 Acho que há mudanças permanentes na minha aparência, que me fazem parecer sem atrativo.
3 Acredito que pareço feio.

15
0 Posso trabalhar tão bem quanto antes.
1 É preciso algum esforço extra para fazer alguma coisa.
2 Tenho que me esforçar muito para fazer alguma coisa.
3 Não consigo mais fazer qualquer trabalho.

16
0 Consigo dormir tão bem como o habitual.
1 Não durmo tão bem como costumava.
2 Acordo 1 a 2 horas mais cedo do que habitualmente e acho difícil voltar a dormir.
3 Acordo várias horas mais cedo do que costumava e não consigo voltar a dormir.

17
0 Não fico mais cansado do que o habitual.
1 Fico cansado mais facilmente do que costumava.
2 Fico cansado em fazer qualquer coisa.
3 Estou cansado demais para fazer qualquer coisa.

18
0 O meu apetite não está pior do que o habitual.
1 Meu apetite não é tão bom como costumava ser.
2 Meu apetite é muito pior agora.
3 Absolutamente não tenho mais apetite.

19
0 Não tenho perdido muito peso se é que perdi algum recentemente.
1 Perdi mais do que 2 quilos e meio.
2 Perdi mais do que 5 quilos.
3 Perdi mais do que 7 quilos.

Estou tentando perder peso de propósito, comendo menos: Sim_____Não_____

20
0 Não estou mais preocupado com a minha saúde do que o habitual.
1 Estou preocupado com problemas físicos, tais como dores, indisposição do estômago ou constipação.
2 Estou muito preocupado com problemas físicos e é difícil pensar em outra coisa.
3 Estou tão preocupado com meus problemas físicos que não consigo pensar em qualquer outra coisa.

21
0 Não notei qualquer mudança recente no meu interesse por sexo.
1 Estou menos interessado por sexo do que costumava.
2 Estou muito menos interessado por sexo agora.
3 Perdi completamente o interesse por sexo.

_____ Subtotal da Página 2

_____ Subtotal da Página 1

_____ Escore Total.

ANEXO E – Questionário de Controle de Pensamentos

A maioria das pessoas têm em alguns momentos pensamentos desagradáveis e/ou pensamentos que elas não desejariam ter (na forma de palavras e/ou imagens), que podem ser difíceis de controlar. Nós estamos interessados nas técnicas que você geralmente usa para controlar esse tipo de pensamento.Abaixo estão listadas coisas que as pessoas fazem para controlar esses pensamentos. Por favor, leia cada frase com cuidado, e indique com que freqüência você usa cada uma dessas técnicas circulando o número apropriado. Não existem respostas certas ou erradas.O melhor é que você não gaste muito tempo pensando sobre cada uma das frases.

Quando eu tenho um pensamento desagradável ou não desejado:

	Nunca	Às vezes	Freqüentemente	Quase sempre
1. Eu tento trazer imagens positivas à mente	1	2	3	4
2. Eu digo a mimmesmo (a) para não ser tão idiota	1	2	3	4
3. Eu me concentro no pensamento	1	2	3	4
4. Eu troco o pensamento por outro pensamento ruim de menor importância	1	2	3	4
5. Eu não falo com ninguém sobre o pensamento	1	2	3	4
6. Eu me dou uma punição por pensar tal pensamento	1	2	3	4
7. Eu me concentro em outras preocupações	1	2	3	4
8. Eu guardo opensamento para mim mesmo (a)	1	2	3	4
9. Eu me ocupo com trabalho	1	2	3	4
10.Eu questiono se o pensamento é válido	1	2	3	4
11.Eu fico com raiva de mim mesmo (a) por ter o pensamento	1	2	3	4
12.Eu evito falar sobre o pensamento	1	2	3	4
13.Eu grito comigo mesmo (a) por ter o pensamento	1	2	3	4
14.Eu analiso o pensamento racionalmente	1	2	3	4

	Nunca	Às vezes	Freqüentemente	Quasesempre
15.Eu dou um tapa ou um soco em mim mesmo (a) para parar o pensamento	1	2	3	4
16.Eu busco um pensamento agradável	1	2	3	4
17.Eu procuro saber como meus amigos lidam com esse pensamento	1	2	3	4
18.Eu me preocupo com coisas menos importantes	1	2	3	4
19.Eu faço alguma coisa que eu gosto	1	2	3	4
20.Eu tento interpretar o pensamento de outra forma	1	2	3	4
21.Eu penso em alguma outra coisa	1	2	3	4
22.Eu penso mais em um problema de menor importância	1	2	3	4
23.Eu tento pensar de uma maneira diferente	1	2	3	4
24.Eu penso sobre minhas preocupações do passado	1	2	3	4
25.Eu pergunto aos meus amigos se eles têm pensamentos parecidos	1	2	3	4
26.Eu me concentro em pensamentos negativos diferentes	1	2	3	4
27.Eu me pergunto o motivo de ter este pensamento	1	2	3	4
28.Eu digo a mim mesmo (a) que alguma coisa ruim vai acontecer se eu tiver este pensamento	1	2	3	4
29.Eu converso com um amigo(a) sobre o pensamento	1	2	3	4
30.Eu me mantenho ocupado(a) com outra coisa	1	2	3	4

ANEXO F – Questionário de Ruminação e Reflexividade

Responda os itens abaixo assinalando o número que melhor representa a sua opinião, de acordo com a chave de respostas apresentada.

1	2	3	4	5
Discordo totalmente	Discordo	Neutro	Concordo	Concordo totalmente

1- Minha atenção é freqüentemente focada em aspectos de mim mesmo sobre os quais eu gostaria de parar de pensar.	1 2 3 4 5
2- Eu sempre pareço estar remoendo, em minha mente, coisas recentes que eu disse ou fiz.	1 2 3 4 5
3- Às vezes, é difícil para mim parar de pensar sobre mim mesmo.	1 2 3 4 5
4- Muito depois de uma discordância ou discussão ter acabado, meus pensamentos continuam voltados para o que aconteceu.	1 2 3 4 5
5- Eu tendo a ruminar ou deter-me sobre coisas que acontecem comigo por um longo período depois.	1 2 3 4 5
6- Eu não perco tempo repensando coisas que já estão feitas e acabadas.	1 2 3 4 5
7- Eu freqüentemente fico revendo em minha mente o modo como eu agi em uma situação passada.	1 2 3 4 5
8- Eu freqüentemente me pego reavaliando alguma coisa que já fiz.	1 2 3 4 5
9- Eu nunca fico ruminando ou pensando sobre mim mesmo por muito tempo.	1 2 3 4 5
10- É fácil para mim afastar pensamentos indesejados da minha mente.	1 2 3 4 5
11- Eu freqüentemente fico pensando em episódios da minha vida sobre os quais eu não devia mais me preocupar.	1 2 3 4 5
12- Eu passo um bom tempo lembrando momentos constrangedores ou frustrantes pelos quais passei.	1 2 3 4 5
13- Coisas filosóficas ou abstratas não me atraem muito.	1 2 3 4 5
14- Eu realmente não sou um tipo meditativo de pessoa..	1 2 3 4 5
15- Eu gosto de explorar meu interior.	1 2 3 4 5
16- Minhas atitudes sobre as coisas fascinam-me.	1 2 3 4 5
17- Eu realmente não gosto de coisas introspectivas ou auto reflexivas.	1 2 3 4 5
18- Eu gosto de analisar por que eu faço as coisas.	1 2 3 4 5
19- As pessoas freqüentemente dizem que eu sou um tipo de pessoa introspectiva , "profunda".	1 2 3 4 5

20- Eu não me preocupo em auto analisar-me.	1 2 3 4 5
21- Eu sou uma pessoa muito auto investigadora por natureza.	1 2 3 4 5
22- Eu gosto de meditar sobre a natureza e o significado das coisas.	1 2 3 4 5
23- Eu freqüentemente gosto de ficar filosofando sobre minha vida.	1 2 3 4 5
24- Não acho graça em ficar pensando sobre mim mesmo.	1 2 3 4 5

ANEXO G - Lista de pares de palavras apresentadas no experimento

GRUPO 1 - PISTA	**GRUPO 1 - ASSOCIADA**
Estranho	Música
Chave	Jogo
Lanterna	Outono
Acaso	Espuma
Garrafa	Honra
Motor	Pelado
Professor	Esposa
Dólar	Frio
Braço	País
Cabelo	Reunião
Astronauta	Computador
Cavalo	Vantagem
GRUPO 2	**GRUPO 2**
Cidade	Desculpa
Rodovia	Vermelho
Fogo	Vidro
Gato	Relógio
Avenida	Sociedade
Barril	Jardim
Luta	Mundo
Réptil	Tempo
Paciente	Armário
Bebida	Pensamento
Caderno	Vila
Feriado	Alerta
GRUPO 3	**GRUPO 3**
Escritório	Aranha
Prova	Fogão
Boneca	Exército
Controle	Igreja
Mercado	Colete
Cassino	Passagem
Dentista	Coruja
Agulha	Corda
Chuva	Sério
Força	Calor
Falcão	Jogo
Barra	Leão