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PROGRAMA DE PÓS-GRADUAÇÃO EM PSICOLOGIA
MESTRADO EM PSICOLOGIA – COGNIÇÃO HUMANA

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ATTENTIONAL CONTROL AND BIASES TOWARDS THREAT:
THEORETICAL FOUNDATIONS AND ADAPTATION OF EXPERIMENTAL TASKS

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GRUPO DE PESQUISA COGNIÇÃO, EMOÇÃO E COMPORTAMENTO

ATTENTIONAL CONTROL AND BIASES TOWARDS THREAT:

THEORETICAL FOUNDATIONS AND ADAPTATION OF EXPERIMENTAL TASKS

Dissertação de mestrado apresentada como requisito para a conclusão de curso *stricto sensu* no Programa de Pós-Graduação em Psicologia da Pontifícia Universidade Católica do Rio Grande do Sul.

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Apresentação

Esta dissertação de mestrado foi desenvolvida na área de Cognição Humana do Programa de Pós-Graduação em Psicologia da Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS). Foi coordenada pelo Prof. Dr. Christian Haag Kristensen no grupo de pesquisa Cognição, Emoção e Comportamento. Este projeto foi aprovado pela Comissão Científica da Escola de Humanidades e pelo Comitê de Ética em Pesquisa desta universidade (CEP- 2.064.079 – Anexo A). O projeto visa ao esclarecimento de conceitos ligados a atenção, controle atencional e vieses da atenção, além do desenvolvimento de versões adaptadas de duas tarefas experimentais clássicas para avaliação do viés atencional.

O projeto faz parte de um eixo recente de estudos do grupo de pesquisa, focado em Psicologia Cognitiva Experimental. Conforme o Ato de Deliberação 05/2012 do Programa de Pós-Graduação em Psicologia da PUCRS, a presente dissertação contempla dois estudos. Ambos são apresentados na língua inglesa, sendo o primeiro um artigo teórico intitulado "Attentional Control and Attentional Bias towards Threat: a theoretical review", e o segundo, um estudo empírico intitulado "Adaptation of a Dot-Probe Task with Eye Tracking and of an Emotional Stroop Task: novel indices and psychometric characteristics". O estudo empírico avalia a confiabilidade e validade das tarefas desenvolvidas, e contou com a participação de 103 estudantes universitários voluntários.

Agradecimentos

Os processos executivos, a autorregulação e as influências emocionais nas nossas estratégias mentais e decisões sempre me interessaram. O papel da motivação não esteve no foco teórico deste trabalho. No entanto, como ocorre em todos os eventos psicológicos volitivos, a escolha e o processo de realizar de fato este projeto foi extremamente dependente de *motivação* – e, por consequência, das minhas *fontes* de motivação.

Gastar a nossa reserva motivacional enquanto trabalhamos em algo com sentido para nós é o que melhor nos ensina a *importância* dessas fontes. Trata-se de uma importância que transcende os efeitos práticos e econômicos de simplesmente ser impulsionado para frente. Ela atribui novos significados a outras representações e sentimentos, integrando-se em um conjunto de memórias de amor e carinho que não nos levam a nenhum lugar específico, mas nos trazem uma sensação de realização a cada momento das nossas vidas.

Ao escrever isto, após uma noite em claro precedida por semanas de fazer apenas este trabalho, estou feliz. Quero agradecer às fontes da minha motivação por isso, que foi uma conquista muito mais explicada pela atitude dessas pessoas do que pelas minhas. À minha namorada Laura, que cuidou de mim com tanto carinho ao longo de todo esse tempo, e ao longo de todo o tempo em que nós estamos juntos. Ela é a melhor representação daquele sentimento supracitado de amor e carinho que me acompanha aonde eu for, desde que estejamos em qualquer projeto juntos.

Se houve alguém que possibilitou esse trabalho, foi minha mãe. Não pelos motivos óbvios, mas por todos os motivos maravilhosos e ilógicos pelos quais uma mãe tão provedora pode existir. Por esses motivos, seja lá quais forem, sou muito grato. À minha família, a quem amo e de quem sempre sinto saudade (especialmente, agora, da minha irmã e da minha afilhada). Mais diretamente, à minha eqüipe de pesquisa incrível, que muitas vezes me salvou e salvou este projeto do fracasso total (ao menos eu espero!). Muito obrigado a vocês 5! Vocês são as melhores e o melhor, e eu desejo todo o sucesso do mundo para vocês. Todos do meu grupo de pesquisa foram essenciais, assim como vários colegas e amigos. Eu resolvi muitos problemas desse mestrado por meio de conversas totalmente inusitadas, e agradeço por isso também. A predecessora de todas essas conversas foi a que me direcionou para a Psicologia, e pela qual tenho a agradecer ao meu melhor amigo. Muitas pessoas seguraram as pontas enquanto eu perseguia este objetivo. Obrigado a todos vocês.

Agradeço ao meu orientador, que foi uma daquelas pessoas que confiou tanto em mim – agindo de acordo com essa confiança – que me deu motivação para me dedicar ao máximo a este projeto, especialmente na sua fase final. Meus professores e as pessoas na PUCRS que fizeram isto possível todos os dias também vão ficar marcadas na minha memória. Quero agradecer ao CNPq pelo suporte financeiro, que foi indispensável para qualquer qualidade que este trabalho possa ter, além de ser uma fonte importante de motivação. Finalmente, agradeço a todos que participaram deste estudo com tanta boa vontade. A vocês, por quem este objetivo foi alcançado:

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Sumário

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Abstract

Attention is a multifaceted construct, one that has been at the center of discussions across several moments in the history of philosophy and psychology. The characteristic of attention to influence and regulate many other psychological process (e.g., consciousness, memory, decision-making) stresses its importance, and logically results in a hardship in segregating its theoretical boundaries and clearly defining this phenomenon. In a current empirical field of research on attention, biases of attentional orientation to threatening stimuli are investigated. However, models generated from empirical findings lack sustentation on well-established theoretical models of attention, and confusion exists across published experimental studies. Furthermore, experimental tasks to assess biases towards threat require integration with new operationalization and analysis strategies, which can provide better sensitivity, validity and measurement reliability, such as eye tracking and the novel index of attentional bias variability (ABV).

This dissertation is included in the subarea number 7.07.02.03-9 of the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) – Experimental Psychology (Attentional and Cognitive Processes) – which integrates the broader area of Psychology. Two studies are presented to answer to the need of advancing research about attention, attentional control (AC) and attentional bias relative to threat (ABT). Firstly, a theoretical study provides a historical overview of psychological research on attention, from the founders of modern Psychology to current neuropsychological integrative research and empirically-oriented models. This review is expected to clarify constructs of attention and to differentiate these constructs from those of other Psychological domains. Instead of segregating research fields, this is likely to promote a dialogue between fields that research the same phenomena – but measure them differently and attribute to them different names.

Following this theoretical review, an empirical study is presented, which proposes two adaptations of classical experimental tasks to measure ABT: the Dot-Probe Task (DPT) and the Emotional Stroop Task (EST). On the EST, task design is altered to account for important theoretical considerations and to better adapt the task to the measurement of ABV. On the DPT, a surprisingly rare integration of reaction times and eye tracking measures is established, and novel indices to calculate ABT and ABV are proposed. The reliability and validity of indices in both tasks is investigated with university students and through the differentiation of such indices between groups of high vs. low symptoms of anxiety and posttraumatic stress. The importance of pursuing the improvement of psychometric qualities of experimental tasks is discussed in depth upon the findings of the study, including recommendations to future experimental designs.

Keywords: attentional control; attentional bias; Dot-Probe; Emotional Stroop; eye tracking; attentional bias variability

Resumo

A atenção é um construto multifacetado, que esteve historicamente por diversas vezes no centro de discussões filosóficas e psicológicas. O caráter influente da atenção sobre diversos outros processos psicológicos (e.g., consciência, memória, tomada de decisão) salienta sua importância, e logicamente resulta em uma dificuldade na segregação de suas fronteiras teóricas e na definição clara desse fenômeno. Em um campo de pesquisa empírica atual sobre atenção, vieses da orientação atencional para estímulos ameaçadores são investigados. Porém, falta aos modelos embasados em

achados empíricos nesse campo a sustentação em modelos teóricos bem estabelecidos de atenção, e existe confusão nos estudos experimentais publicados. Além disso, tarefas experimentais para avaliar vieses da atenção para a ameaça necessitam de integração com novas tecnologias e estratégias de análise, as quais podem gerar mais sensibilidade, validade e confiabilidade, como o rastreamento ocular e o novo índice de variabilidade do viés atencional (ABV).

Esta dissertação está incluída na subárea de número 7.07.02.03-9 do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) – Psicologia Experimental (Processos Cognitivos e Atencionais) – a qual integra a grande área de Psicologia. Dois estudos são apresentados para suprir a necessidade de avanço no estudo sobre atenção, controle atencional (AC) e viés atencional em relação à ameaça (ABT). Em primeiro lugar, um estudo teórico fornece uma visão histórica da pesquisa psicológica da atenção, desde os fundadores da Psicologia moderna até a pesquisa neuropsicológica integrativa atual e os modelos orientados empiricamente. Esta revisão busca esclarecer conceitos da atenção e diferenciar esses conceitos dos de outros domínios psicológicos. Em vez de segregar áreas de pesquisa, é provável que essa estratégia promova um diálogo entre campos que pesquisam o mesmo fenômeno - mas o medem de forma diferente e atribuem-lhe nomes diferentes.

Na sequência dessa revisão teórica, é apresentado um estudo empírico, que propõe duas adaptações de tarefas experimentais clássicas para medir o ABT: a Tarefa Dot-Probe (DPT) e a Tarefa Stroop Emocional (EST). Na EST, o desenho da tarefa foi alterado para levar em conta considerações teóricas importantes e para melhor adaptar a tarefa à medida de ABV. Na DPT, uma integração surpreendentemente rara de tempos de reação e medidas de rastreamento ocular é estabelecida, e novos índices para calcular o ABT e o ABV são propostos. A confiabilidade e validade dos índices em ambas as

tarefas foi investigada com estudantes universitários e através da diferenciação dos mesmos índices entre grupos de sintomas altos vs. baixos de ansiedade e estresse pós-traumático. A importância de progressivamente melhorar as qualidades psicométricas dessas tarefas experimentais é discutida em profundidade levando em conta os achados do estudo, incluindo recomendações para futuras adaptações dessas tarefas.

Palavras-chave: controle atencional; viés atencional; Dot-Probe; Stroop emocional; rastreamento ocular; variabilidade do viés atencional

Theoretical Article

Attentional Control and Attentional Bias towards Threat: a theoretical review

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Abstract

The current article revisits psychological and neuropsychological models of attention in order to clarify the definition of attentional control and understand its role in the orientation of cognitive resources to threat. A historical overview of definitions of attention is presented, followed by the proposition of an integrative theoretical model. Empirical applications of attentional constructs on research about attentional bias towards threat are discussed. Links between empirical findings and theoretical constructs are proposed, and main definitions are summarized.

Keywords: attention; empirical models; neuropsychology; trauma

Introduction

> With over 150 studies that have established the existence and typical magnitude of the threat-related bias in anxious individuals from different populations and with a variety of experimental conditions, it appears as if little will be gained from additional studies of threat-related bias unless these are strongly driven by theory. (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007, p. 18)

Bar-Haim et al. (2007) concluded a meta-analysis about attentional bias towards threat (ABT) stating that strengthening the link between empirical research and theoretical models of attention was in order. More than a decade later, confusion still exists in the definition of structures, processes and functions related to attention, including its executive control and its frequent automatic biases. This confusion is not unprecedented. Though great theoretical progress has already been achieved, the hardships involved in defining attention were important enough to be the central focus of the founders of modern psychology in the 19th century, and to turn the eyes of behaviorists away in the beginning of the 20th century. This review pictures the most relevant theoretical efforts in defining attention, *attentional control* (AC) and ABT, a task facilitated by the important work of Ronald Cohen (2014). The impact of theoretical knowledge on current empirical research is also discussed.

Several definitions of the term *attention* (from the Latin *attendere*, *ad* "to, toward" and *tendere* "stretch") exist in the common sense. These definitions will most likely include a relationship with consciousness, that is, the positioning of an object or a thought process inside of human conscious experience. Another common element in the definition of attention is selection, that is, the favoring of one strain of thought or set of stimuli instead of others. These selected thoughts or stimuli acquire greater vividness in comparison with others, which remain less vivid until disengagement occurs from the previously attended stimuli (Cohen, 2014).

Common analogies of attention include a spotlight, camera adjustable lenses and the tuning of a radio, all of which have both filtering and focusing properties. That is, they reduce the vividness of unattended stimuli in favor of enhancing vividness and clarity of other stimuli in a given context. These properties are widely recognized as core components of all attentional processes. However, such properties also exist in models of other psychological processes (sequences of operations) and systems (structures with interactions between its components), which are related to different cognitive domains (e.g., memory, intelligence, decision-making). The considerable intersection between models naturally results in confusion. For example, current models include working memory and selective attention as subcomponents of EF (e.g., Diamond, 2013).

Novel fields of study may add more relevant information into the theoretical mix. Since the early studies of Broca (1861), through Luria (1966) and Damasio (1994), neuroscience has provided evidence for the previously inferred links between neurobiology and information processing (i.e., neuropsychology). The observation of activated regions of the brain during experimental tasks is currently leading the research in experimental cognitive Psychology.

Contributions to the understanding of attention also arise from an intrinsically empirical field of Psychology: experimental psychopathology. The study of unhealthy alterations in cognitive functioning (i.e., mental disorders) sometimes results in a better understanding of specific functions. This is true not only for early neuropsychological studies, with observed functional deficits after brain lesions (e.g., the impairments in verbal expression mapped by Broca), but also through differential performance in experimental tasks (e.g., because of ABT) observed in anxiety disorders and trauma-related disorders.

Several studies relate posttraumatic symptoms with deficits in EF (Aupperle, Melrose, Stein, & Paulus, 2012; DeGutis et al., 2015; Polak, Witteveen, Reitsma, & Olff, 2012) and with heightened ABT (Bar-Haim et al., 2007; Cisler & Koster, 2010) or, in more recent studies, with heightened attentional bias variability (ABV) (Badura-Brack et al., 2015; Iacoviello et al., 2014; Naim et al., 2015) and with poor integration of brain regions related to semantic and automatic threat processing (Liberzon & Abelson, 2016; Reiser et al., 2014). Despite excellent material about ABT (for a review, we recommend Cisler & Koster, 2010) definitions about whether attentional processing involved in ABT is controlled or automatic are “blurry at best” (p. 211), and terminology is confusing as well.

In this article, relevant psychological models of attention are reviewed, clarifying and differentiating theoretical definitions, with the aim of providing an overview of models of AC and ABT. We expect to provide a better understanding of what research has revealed about the executive control of attention and about how AC interferes in ABT. Specifically, empirical findings of studies with traumatized samples will be highlighted, given that such findings are key for interpretations regarding ABV. A summary of relevant concepts is found on Table 2.

Early Models of Attention

Experimental Psychology

Following centuries of philosophical inquiry about the nature and the constraints of the human mind, Wundt, Titchener, James and others experimental researchers dedicated their studies to define attention and consciousness. This was sought by experimentally investigating possible structural and functional classifications of mental processes.

Despite methodological and theoretical differences, these authors agreed on a view of attention as a focusing of conscious experience. Attended mental or environmental phenomena were those that gained more relevance in consciousness. For example, Wilhelm Wundt (1897) defined consciousness as a state of relationship between psychic events (i.e., mental representations). Psychic events are generated through *perception* of external and internal stimuli. The integration of these events (each with its own spatial and temporal characteristics) into a coherent mental flow is what characterizes *consciousness*.

In the center of conscious experience exists a focal point, inside of which aspects of mental representations are clearer and distinct from others at a given time. The clear and distinct conscious experience that exists in the scope of this focal point was called *attention* by Wundt. In his words, “the state which accompanies the clear grasp of any psychical content and is characterized by a special feeling, we call *attention*. The process through which any such content is brought to clear comprehension we call *apperception*” (p. 209). Salient stimuli can *intrude* in the focal point of attention, as well as be actively *inserted* in it by the individual. This differentiation of *passive* (i.e., automatic, bottom-up) and *active* (i.e., volitional, top-down) forms of attention is paramount to models of AC developed much later.

James (1890) agrees with this specification of different forms of attention. He strongly opposed a view of attention based only on experience and on stimulus characteristics and set the foundations for the study of an executive (or *top-down*) form of attention, linking it with motivation: “my experience is what I agree to attend to. […] Without selective interest, experience is an utter chaos. Interest alone gives accent and emphasis, light and shade, background and foreground - intelligible perspective, in a word” (p. 402). A more volitional form of attention requires effort, says James, especially when individual goals are directed to dull stimuli that are not naturally salient, or that have to be attended to for longer periods. Passive attention, on the other hand, is automatic and functions continuously.

Titchener (1908) contributed with the mapping of properties that increase stimulus *clearness*, that is, stimulus characteristics that tend to elicit an attentional response. Such stimulus characteristics include intensity, sudden onset, sudden change in properties, movement, cessation and novelty or strangeness of the stimulus. He also defined a process of inhibition of concurrent stimuli, and a law of prior entry: “the stimulus for which we are predisposed requires less time than a like stimulus, for which we are unprepared, to produce its full conscious effect” (p. 251). That means that prior indications of the appearance of a given stimulus will clear its way into consciousness. Taken together, these ideas attest that it is possible for an individual to attend to (i.e., make clearer) a stimulus with less intensity, even when it concurs with others that are more intense, if it is already exists in some form in the individual's conscious experience. Studies on stimulus priming – and ABT – spawn from this concept.

Furthermore, the extensive experimentation that occurred at that time generated a comprehensive view of characteristics of attention that would serve as foundation for future models. Among methodologic limitations (e.g., introspection as means of observation), researchers such as Pillsbury (1913) investigated for how long attention was maintained in visual, auditory and tactile stimuli, and how many stimuli could simultaneously occupy this focus of processing. Though this served to support fragile concepts such as *pulses of attention* with defined durations, it also constitutes the foundation of models of working memory, which are still linked with attention today. Pillsbury even identified brain regions that would be associated with attention and pathologies related to attentional decay. He also described two physiological processes underlying attention: facilitation (i.e., increase of activity on one cell by the action of another) and inhibition (i.e., opposition of one cell to the activity of another). Studies on AC and EF are widely based on cognitive interpretations of such processes.

Aggregate findings and theoretical propositions of the aforementioned authors laid the foundations for the models of attention that followed – after a significant interval of about half a century. Psychological processes related to attention and consciousness were widely overlooked by behavioral researchers in the beginning of the 20^{th} century, who focused on observable psychological manifestations of stimulus-response interactions. Behaviorists went through great effort to categorize every mental process into behavior, including in nomenclature. As George Miller states in a historical personal account: “perception became discrimination, memory became learning, language became verbal behavior, intelligence became what intelligence tests *test*” (2003, p. 141). Even so, findings from behaviorist researches contributed to the study of attention, such as the differentiation by Pavlov between neural and behavioral inhibition, and the identification of the *orienting response* (OR) in dogs, reffered to by him as the “what is it” reflex (Cohen, 2014). This is discussed further in this article.

Simultaneously with behaviorism in the US, however, researchers from other nationalities still concerned themselves with the human mind. Bartlett was working with memory in Cambridge; Piaget wrote to many about the mental development of children; and, in Moscow, Luria saw the brain and mind as a whole (Miller, 2003). Furthermore, Gestalt psychologists in Germany remained concerned with the formation of visual patterns during perception and with the influences of properties of stimuli on mental representations (Wagemans et al., 2012). Several insights emerged regarding characteristics of stimuli (e.g., proximity, similarity, symmetry) that influenced attentional selection, though executive attention and volition were still left in the background.

Communication, Cognition and Attention

The cognitive revolution turned interests back to whatever happened between stimulus and response. It was a revolution not conducted solely (or primarily) by Psychologists, however. Important works identified as the sparks of such revolution were about communication, such as Shannon and Weaver’s (1949) mathematical model about processes in between the emission and reception of *information* – including possible distortions (i.e., noise) and limitations (i.e., capacity) that occur in the communication channels. Computational concepts (e.g., bits of information) started to appear in psychological experiments, which approached once again whatever might happen to alter information inside the mind.

Shannon's mathematical approach gave way to Chomsky's (1957) syntactic theory, which proposed a more complex (and mentalistic) way to study a language's grammar. This focus on mental processes that determine transformations in language served as inspiration to the soon-to-be cognitive psychologists, who started to think of *mental structures* and *processes* which are key to transforming and understanding information. Very quickly, *information* theory gave way to *cognitive* theory. As stated in Miller's account (2003), cognitive science emerged as an interdisciplinary movement, with essential contributions from studies about cybernetics, artificial intelligence, linguistics and computer-simulated cognitive processes.

To an in-depth study of attention, however, *information theory* remained very influential and generated models applying the filtering of information in communication systems to psychological organisms. The distinction between *active* and *passive* forms of attention still remained from the end of the 19th century and was still an uncomfortable problem for researchers trying to establish at what point in processing does information actually get filtered (i.e., where is the *bottleneck* of information). At what point do our goals and expectations interfere, how do we divide our processing between different activities and what type of stimuli go through our filtering mechanisms? Opposing theoretical propositions started to emerge, with their focus divided between automatic *filtering* mechanisms and top-down *selection* of stimuli according to predisposed sets.

Broadbent (1958) generated a model with great influence on the understanding of automatic and multichannel processing, represented in Figure 1. With support from experimental evidence of selective listening, he stated that perceived stimuli enter processing in parallel through several channels of communication and remain only for a few seconds at a short-term store (i.e., a working memory buffer) before being filtered through a capacity-limited serial processing system. Stimuli may return to the short-term store after central processing, what allows them to be continuously attended to, at the expense of limiting the entry of new information past the central processer. This would be analogous to actively keeping a telephone number in short-term memory at the expense of paying little attention to an ongoing conversation.

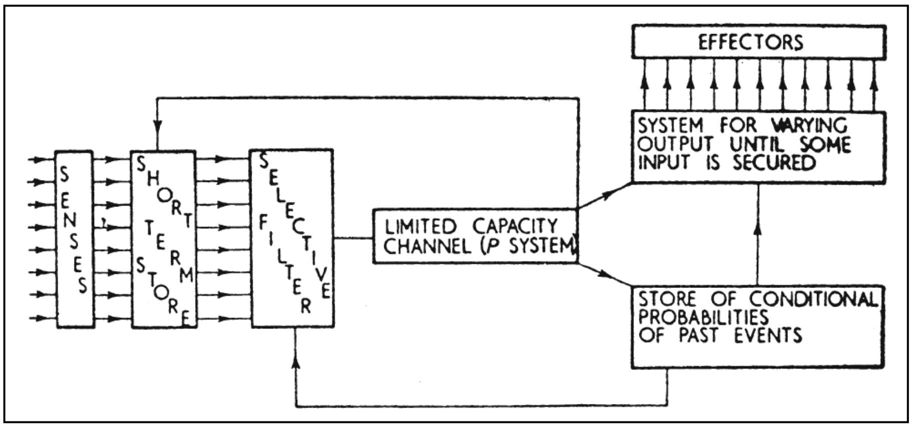

Figure 1. Broadbent's information-flow diagram
Source: Broadbent, D. E., 1958, *Perception and communication*, p. 299. Elmsford, NY, US: Pergamon Press, Inc. doi: 10.1037/10037-000

Note: the positioning of the bottleneck after the short-term store was later criticized and remodeled by other authors, but made it possible for Broadbent to explain experimental data on multichannel monitoring – that is, secondary unattended channels remain in processing at a certain level (Cohen, 2014).

The relationship between immediate (or working) memory and attention becomes significantly more relevant in this model. Attending to information requires (1) passively *orienting* to its properties; (2) *categorizing* it into different channels, what requires more active processing; (3) *storing* information from different channels for a limited time; while (4) different amounts of processing are dedicated to each channel due to *capacity* limitations (i.e., *filtering*); (5) actively dealing with filtered information according to conditional probabilities, body states (e.g., hunger, sexual drive) and predefined sets or strategies in order to decide which amount of processing to further dedicate to that information; and (6) generating adequate responses.

There is still much more to Broadbent's contribution, inclusively in the ideas that spawned from later reviews of his model. For example, the idea of one bottleneck positioned either at an earlier or later stage of processing was further reassessed. At the extreme opposite of this idea were researchers such as Neisser (1976), who completely refuted the bottleneck and advocated that we perceive only what is in accordance with our predetermined *schemata*, a concept developed by Bartlett in studies about memory (1932) defining cognitive structures of expectations, previous experiences and goals. Perceiving stimuli, says Neisser, does not require filtering out other stimuli, but is an active top-down process of identifying how contextual stimuli transform and relate to our inner schemata. We perceive what is consistent with an inner set, the rest is simply ignored. This would explain why an individual always attends to an utterance of his name, even when it occurs in a channel that was being unattended to.

This proposition fails to explain, however, how we are able to perceive new and unexpected stimuli and fails to account for physiological evidence of inhibition and filtering processes in all levels of perception. As Cohen (2014) observes, a more adequate interpretation may include both bottom-up and top-down explanations: schemata define why certain stimuli are to be attended and which are the operating instructions for filtering mechanisms, while these filters define how quickly to process stimuli and which stimuli will be left out according to the system's capacity.

A further development from the concept of schemata also aided in understanding automatization. Activities and strategies that once required conscious control and effortful processing, after recurrent practice and repetition, may generate a schema or a set of predefined processes and semantic relationships. Processes that become automatic no longer require attentional processing to occur in known conditions and allow individuals to easily divide attention and to multitask (e.g., singing while taking a shower). However, an exception occurs when such processes become inadequate to a given situation and require inhibiting, supervising or set-shifting. Then, attention is once again called to action in its executive form (i.e., AC). In fact, processes that are sufficiently automatized will become difficult to attend to, and might interfere with related conscious tasks (Shiffrin & Schneider, 1977). A significant effort is required to supervise or inhibit automatic strategies such as responding to the meaning of a written word (e.g., “red”) instead of to its usually irrelevant physical properties (e.g., the fact that it is written in blue). Overriding this automatization is an effort required in the Stroop task (Stroop, 1935).

Another milestone in the comprehension of automatic processes regarded priming and expectancy effects. Titchener (1908) had already noted that predisposition to a stimulus would shorten its processing time. This was replicated in experimental studies requiring visual detection of signals (e.g., Posner, Snyder, & Davidson, 1980) which provided cues prior to the appearance of the stimulus (e.g., onset location, shape). Findings sustained that cues about location resulted in faster reaction times.

Furthermore, studies with anticipatory cues (Posner et al., 1980) specified that (1) the general warning about a stimulus appearance will shorten reaction times, due to a non-specific increase in *arousal* following the warning; (2) events that are more likely to occur are processed faster than less expected events (i.e., the *expectancy* effect); and (3) the presentation of a stimulus that contains characteristics of a succeeding stimulus will result in faster reaction times to the latter, that is, the first stimulus *primes* the reaction time of the second stimulus. An example is the presentation of semantically-related words in sequence (e.g., *mammal* followed by the primed *dog*), but the opposite strategy still provides interesting results: when the preceding stimulus prompts incorrect information about the following stimulus, reaction times may be delayed (e.g., presenting *feathered* prior to *dog*).

The work of information theorists and experimental psychologists revived the concepts from 19th century founders of modern Psychology, providing further theoretical specification of attentional processes and experimental evidence to support it. These approaches still lacked differentiation across different applications in other cognitive domains (e.g., memory, perception, decision-making), still neglected the influence of motivation and still treated attention as a unitary process occurring prior to or alongside perception. However, the advances achieved at that time brought researchers back to uttering shadowed terms such as *consciousness*, *information*, *executive attention*, *expectations* and *schema*, with the experimental data to support it and to sustain the cognitive revolution until it reached its current status.

Psychometrics and neuropsychology

Psychometric tests were a significant historical force in attentional research, and heavily influenced the understanding of attention. Several tasks were developed since the first normative measurements of intelligence (e.g., Spearman, 1927), a construct which was further operationally specified and led to several related constructs, including EF. Normative tests initially utilized to asses EF were increasingly comprehended from an attentional perspective and are now utilized by neuropsychologists conjointly with tasks derived from a more experimental neuroscientific branch of attentional research. Inferences are made about the relationship of performance in such tasks with cognitive processing and, ultimately, with neurologic function. An advantage of the use of neuropsychological clinical tasks is the extensive literature segregating the EFs assessed in each task, what may provide a degree of certainty regarding their sensitivity.

Most usual definitions of attentional behaviors in clinical neuropsychological studies spawn from testing. These definitions include (1) *focused attention,* a function of the amount of information the individual selects in a limited spatial-temporal frame, or simply put, how *much* of engaged processing is dedicated to a given task, such as complex problem-solving (e.g., arithmetical tests); (2) *selective attention,* or the ability to prioritize the direction of attentional focus to different stimuli or stimuli features, traditionally assessed through the Color-Word Stroop or Symbol Search tasks; (3) *alternate attention*, measured by performance when attention needs to be recurrently switched between sets or stimuli, such as in the Trail-Making Test part B; usually confused with (4) *divided attention,* required to direct attention capacity to more than one channel simultaneously; and (5) *sustained attention*, or the ability to maintain attentional resources dedicated to a task for extended periods, despite a natural tendency of decaying, traditionally assessed in longer tasks involving vigilance or visual search (Cohen, 2014).

Inhibition, set-shifting and response initiation are often target behaviors in neuropsychological tests assessing *attention*, what stresses the conceptual overlap between AC and EF. It seems that researchers based on a clinical neuropsychological perspective usually choose between phenomenological definitions of attention and, when discussing specific executive behaviors in attentional processes, prefer the term EF, while experimental neuroscience and cognitive researchers chose the specific terminology of AC for the same functions. This intersection (i.e., AC and EF) is further discussed in this article.

Contemporary Theoretical Models of Attention and AC

The end of the 20th century and beginning of the 21st was characterized by a shift in the focus of attentional research. From information-processing models treating attention as a mechanism of perception (*sensory selective attention*), researchers started to analyze attention to already processed information, as related to intention, motivation and response selection (*executive attention*). The view of a parallel sensorial process that was bottlenecked by attention into central serial processing was progressively abandoned, towards a view of different attentional functions acting conjointly (in parallel) to promote efficiency and accuracy all the way through processing. Furthermore, the relationships between attention, executive control, self-awareness and consciousness were re-stablished and empirically evidenced. This was made possible by breaching the gap between the areas of cognitive psychology, neuroscience and clinical neuropsychology, along with technological advances (e.g., Functional Magnetic Resonance Imaging [fMRI] of the brain).

The Supervisory Attentional System

The shift towards a the focus on executive attention is well represented by Norman and Shallice's (1986) proposition of a *Supervisory Attentional System* (SAS), a deliberate mechanism with global influence over schemas of information processing, actions and responses, acting especially in unusual situations that demand control over automatic processes. Their drawn representation of the model is seen on Figure 2.

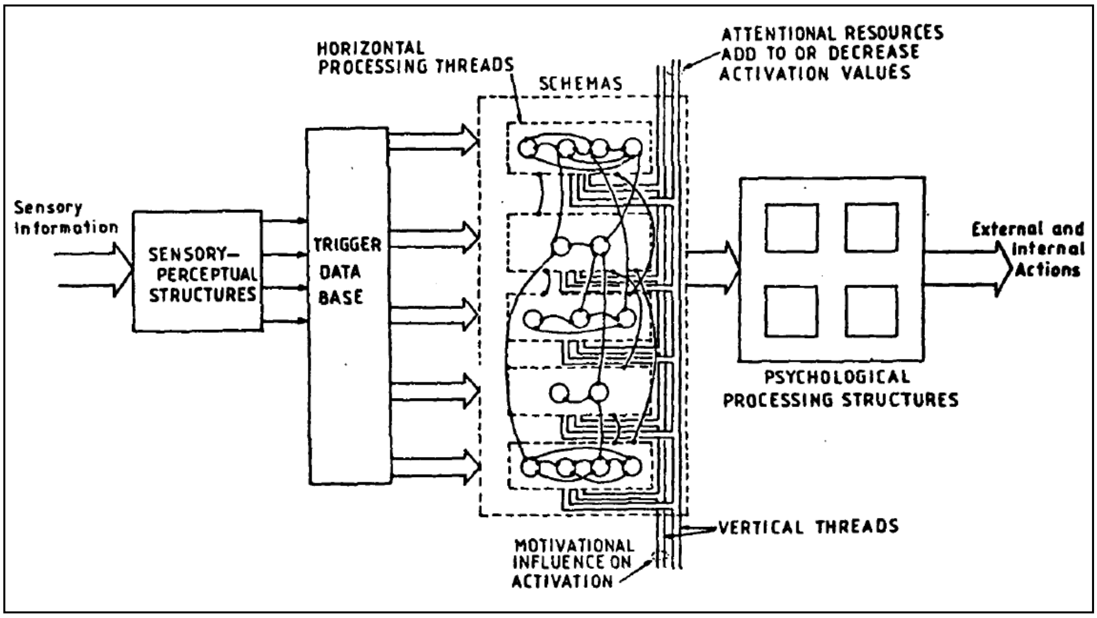

Figure 2. The role of executive attention in selecting schemas for processing and responding

Source: Attention to Action - Norman, D. A., & Shallice, T., 1986, *Consciousness & Self-Regulation, 4*, p. 11. doi:10.1007/978-1-4757-0629-1_1

The vertical threads spawn from the SAS and act upon schemas, which are possible horizontal sequences of processing, each with a specific activation threshold (or activation value) – not the same as Bartlett's (1932) schemata. The SAS either adds to or subtracts from these activation values, influencing which schemas will be activated or inhibited. Then, other psychological processing structures are responsible for decision-making and response selection among the activated schemas, as well as to generate effective action. The SAS is therefore a strong mediator between stimuli, possible schemas, response selection and action.

In time, a recurrently activated schema automatically increases its activation probability and will no longer requires SAS influence in order to be activated – however, such a schema may need more SAS control in order to be inhibited, what may be required in exceptional situations when the recurrently activated schema is inadequate. A degree of SAS monitoring occurs to identify these possible problematic situations (Norman & Shallice, 1986).

It is important to stress that schema activation is initially dependent of correspondence to *trigger conditions* of each possible processing chain. Such conditions are compared with the available triggers in the *trigger database*, and a high correspondence will result in a higher probability of activating the schema in question. The SAS is capable of overriding these conditions however, inhibiting a schema despite favorable activating conditions, as well as activating a schema despite insufficient correspondence between trigger conditions and the trigger database (Norman & Shallice, 1986).

Another interesting contribution is the role of *motivation*. Internal goals and analysis of possible *rewards* may influence the activation of schemata that will determine how attentional behaviors (e.g., search, focus, selection, sustaining) will occur. This means that motivation might set a schema chronologically *before* the sensory perceptual structures, so that attentional behaviors will orient the sensory organs and perceptual processing in a given direction according to certain internal goals. This may emerge in the form of *concentration* (e.g., effortful attention during sports) or *will* (e.g., getting out of bed very early in the morning). Norman and Shallice (1986) are careful to separate the attentional part of *willful action* (e.g., keeping the long term rewards of getting out of bed in focus, as well as the motor schema required to get up) from the parts that relate to other psychological structures (e.g., actually deciding to get out of bed and doing it). This distinction would still require clarification, as is discussed further in this article.

The SAS was neuroanatomically related by Norman and Shallice (1986) with the frontal lobe, since all deficits reported by Aleksandr Luria (1966) in patients with prefrontal lesions would also be consequences of a poor functioning of the SAS, such as problems in planning, sustaining attention and inhibiting automatic responses in favor of goal-directed ones. Basal ganglia were associated with response selection and initiation (even when little SAS control is in action). Norman and Shallice's model (1986) is based on the idea that automatic processes occur serially (i.e., horizontally), with one information or sequence leading to the next and no consumption of attentional resources, while executive processes act vertically, effortfully resolving conflicts, stablishing hierarchies and changing activation probabilities of automatic processes. It maintains an underlying division of inhibition vs. activation in attentional processes and behaviors.

This model ultimately reflects the parting from an idea of a fixed bottleneck, towards a view of attentional behaviors occurring in several moments of processing. A chronological sense still remains, in that more effortful and conscious top-down processes tend to occur later than involuntary and unconscious bottom-up processes. The mediating role of attention between perception, response selection (including previous patterns and memories) and behavioral action in this model sets attention clearly as an *interface* between perceptual input, memory and higher-order cognition. This view of attention is still maintained today (Cohen, 2014).

Intersection with memory

The role of resolving conflict, promoting hierarchy and monitoring incoming information was previously attributed to another theoretical construct. Baddeley and Hitch (1974) explained working memory as a system composed of processing and buffering slave structures (i.e., a phonological loop and a visuospatial sketchpad) oriented and controlled by a "limited capacity *attentional control* system, the *central executive*" (Baddeley & Andrade, 2000, p. 127). While visual information is maintained and spatially organized in the visuospatial sketchpad and verbal and auditory information is temporarily stored in the phonological loop, a capacity-limited executive attentional structure directs focus and selects information, regulating what is maintained and integrated between the slave structures.

The evident intersection between the central executive and the SAS never went unnoticed. In fact, Baddeley himself attested that Norman and Shallice’s SAS would be a good candidate for the central executive (Baddeley, 2011). The constructs may be interchangeable. The specification of the working memory’s slave structures is just beyond Norman and Shallice’s scope, but could be easily integrated in their model as memory structures that withhold information according to specific automatic strategies and are subject to attentional behaviors from the SAS. Furthermore, automaticity essentially depends on memory. Repetition generates associative memories that can be retrieved in the form of a schema – which is stored in long-term memory. This goes to show that it is unpractical to develop a cognitive processing model that isolates cognitive functions such as memory and attention from each other.

Intersection with EF

If attention and memory are difficult to segregate in theoretical models, segregating AC and EF might prove to be a test of resilience. In a wide range of cognitive phenomena, constructs of AC and EF are interchangeable. In fact, it is unpractical to divide them by function. As Cohen (2014) states: “to a large extent, the executive processes that enable temporal sequencing and complex response planning, production, and control are the same processes that underlie intention and attentional allocation to response selection and control” (p. 348). This similarity extends to the neural basis of these processes, what leads Cohen to choose the term *attention-executive control processes* to describe processes such as response intention, selection, sequencing, initiation, maintenance and switching, not separating them from attention – not even at the motor and behavioral end of response control.

In fact, the definition of three core EFs – the three most objectively, frequently and independently measured – in the referential work of Miyake et al. (2000) still leaves doubt as to what portion of EF does not intersect with attention. The first core EF is *shifting* (i.e., switching back and forth from tasks or mental sets), which is characterized by engagement and disengagement, or even by initiating a new task while dealing with *proactive interference* from a previous task. Miyake et al. (2000) state that this is not the same as shifting visual attention, but do not separate the concept from AC in general:

> Visual attention shifting may be regulated primarily by the parietal lobes and the mid-brain (or the ‘‘posterior *attention* network’’), whereas more executive-oriented shifts may be regulated primarily by the frontal lobes, including the anterior cingulate (or the ‘‘anterior *attention* network’’). (p. 56)

The second proposed core EF (Miyake et al., 2000) is *updating* and monitoring of working memory representations, an EF related to the dorsolateral prefrontal cortex and including functions such as temporal sequencing and monitoring. This EF is a part of Baddeley's (2011) proposition of the *central executive's* functionality, which is in turn interchangeable with Norman and Shallice's (1986) SAS. It is therefore integrally encompassed by a notion of AC – and it is *attentional* in all of its theoretical aspects.

The third core EF proposed by Miyake et al. (2000) is *inhibition* of prepotent and automatic responses. This EF, despite intimately related with all levels of AC, is also present in the more behavioral end of response control, which is theoretically outside of the attentional phenomenon. For example, an interpretation of the effort required in the traditional Stroop task (Stroop, 1935) to inhibit prepotent (and task-irrelevant) responses may focus on the SAS perspective: an executive form of attention decreases the activation value of the prepotent schema, inhibiting it, and favors the activation of a secondary strategy (i.e., naming a physical property of the written word). However, independently of the selection of this schema, the actual decision of inhibiting a motor behavior and the motor inhibition *per se* are not in the range of AC, but inside a broader understanding of executive control or EF.

However, the fact still remains that, in the latter interpretation, if the attentional portion of this inhibiting action would be isolated, what remained would hardly be called *executive*. This final product would be better defined as automatic conflict resolution and motor behavior, with no participation of awareness or volition – which are defining aspects of EF. Thus, when such neuropsychological tasks are utilized to test EF, only a small part of this tested phenomenon appears to lie outside the scope of AC.

Clearer distinctions between AC and EF start to appear in higher-order executive control, such as decision making, planning, creativity and abstract reasoning, which may also go beyond the scope of AC. However, as Cohen (2014) states, these EFs still typically require intensely focused attention, without which they would be unviable: "these higher cognitive functions ultimately are a by-product of more elementary processes, closely tied to attentional control" (p. 348). Impairments in higher-order EFs are also likely to negatively impact attention. The modular study of EFs and the identification of neural networks associated with each independent function of AC contributed to segregating modules and functions inside the SAS (Miyake et al., 2000).

Cognitive Neuroscience

Evidence from cognitive neuroscience (Derryberry & Reed, 2002; Posner & Rothbart, 1998; Posner, Snyder, & Davidson, 1980) aids in explaining both automatic and controlled attentional processes. In the initial allocation of attention, engagement and disengagement are required in order to attend to relevant stimuli. These processes are related mainly to the activation of posterior brain structures, such as the posterior parietal lobe (related to *disengagement*), thalamus (covert *orienting* or *engagement*) and superior colliculus (attentional *shifting*), as well as the limbic system. On the other hand, deliberate AC is related to anterior structures such as the anterior cingulate cortex (ACC) and its connections. In fact, different areas of the ACC are related to different functions of AC (e.g., error detection, conflict supervision, selection).

Posner and Petersen (1990) stated that the different functions carried out by attentional structures in the brain can be defined in cognitive terms. A tripartite division of such functions was proposed, in accordance with the anatomical brain networks identified in empirical research. After theoretical adaptations of the model (Fan, McCandliss, Sommer, Raz, & Posner, 2002), the following three attentional function networks were delineated: (1) alerting, involving initiation and maintenance of a state of vigilance and continued performance; (2) orienting, characterized by selection of information from sensorial and cognitive inputs (i.e., engagement and disengagement); and (3) executive control or executive attention, implicated in the performance of tasks with conflicting information.

According to Posner and Rothbart (1998), the role of executive control extends to self-regulation, including the explicit control of cognitions and behaviors, delaying gratifications and regulating pain and emotion. This third function of attention may be assessed through tasks such as the emotional Stroop, in which inhibition of emotional cues is required for an optimal performance. Self-regulation starts to be developed in early childhood in the regulation of distress and is characterized by connections between cingulate systems and the amygdala.

Cohen (2014) further analyzed frontal lobe areas differentially involved in AC functions, including the (1) dorsolateral, (2) dorsomedial, (3) ventromedial, (4) ventrolateral, (5) orbitofrontal, and (6) anterior cingulate cortices and their connections with other brain regions. He states that "the interactions among these frontal subsystems create competing excitatory and inhibitory response tendencies that provide for attentional control" (p. 956). AC functions governed by interactions of these subsystems include active search, conflict resolution, sequencing, concurrent task performance and switching. For a more specific and current view of neural attentional networks, we recommend the study by Block and Liberzon (2016).

Contributions from Michael Posner include empirical work with *priming* and with *expectancy* biases. Once engagement in a stimulus is *facilitated* by previous information, this usually results in more attentional focus dedicated to the stimulus. If attention is to be directed towards other stimuli, this will require *inhibition* from AC in order to *disengage* from the previous stimulus. An effective way to analyze engagement and disengagement biases is through the Dot-Probe Task (Posner et al., 1980). The work of Michael Posner reflects the significant breaching of limits between neuroscience and experimental cognitive research on attention. This communication between areas of study has made it possible to further differentiate constructs that remained intertwined for centuries. Some of them are presented below.

Awareness, volition and attention

Awareness and volition are defining aspects of consciousness, EF and of executive attention or AC (Posner & Rothbart, 1998). Attention is intimately related with awareness. For example, Wundt's definition (1897) of attentional focus might be translated as the portion of consciousness most imbued with *awareness* at a given moment, even though it is now known that several bottom-up filtering mechanisms may occur with low awareness. On the other hand, all cognitive processes that are named *executive* or *controlled* are also defined by *volition*, a form of active goal-oriented functioning. *Consciousness* is not only defined as the experience of self-control and self-awareness; however, sensorial awareness is the most scientifically approachable aspect of consciousness, which is why it has been a primary focus in the neuroscience of consciousness and attention (Posner & Rothbart, 1998).

Volition is intimately related with self-regulation. Controlled behaviors start early in development with the *regulation of distress*. All further reports of goal-directed behavior and intention may be traced back to this early regulating feature and share a common cingulate-based neural network. Reports of sensorial *awareness*, on the other hand, occur previously in development, as seen in visual orienting paradigms (Posner & Rothbart, 1998). Both volition and awareness also share similar neural networks.

Attentional filtering, selection and focusing might be the sustentation of awareness. In a hypothetical organism with the capacity to perceive, process, integrate and respond to all existing stimuli (including previous experiences) simultaneously, unequivocally and with no increase in energetic demands, attention would be functionally irrelevant, and awareness would likely not have been an evolutionary development. Therefore, as stated by Cohen (2014), the most appealing explanations of consciousness define it as metacognitive by-product of self-regulation, which in turn results from the need of actively filtering, prioritizing, and altering one's own cognitive processing in its relationship with reality.

Volition and awareness are both fundamental for the conscious experience and are hard to segregate empirically, thought this is not impossible. For example, when an individual is dreaming, it is a safe assumption that he is exercising attentional behaviors and is at least partially aware, but volition may have little participation on that specific conscious experience. Conversely, lucid dreaming is characterized by heightening volition in the experience of dreaming (Dresler et al., 2014). Therefore, attention precedes and may occur without awareness, though leading to awareness is an important function of attention, and volition is what differentiate AC from all other attentional phenomena.

Emotion regulation, rewards and executive attention

Emotional activation and the perception of rewards can influence motivational aspects that are crucial to response intention and AC in general. Studies on these areas usually differentiate neural systems involved in *hot* and *cold* executive control – heat serving as an analogy of emotional valence or high perception of reward during a given task. Goal-directed behavior often involves delaying gratification and regulating emotions, both of which would be functions of *hot* AC. Connections of the ventral ACC with the amygdala seem important to hot AC during experimental tasks, while the dorsal portion of the ACC is usually activated in conflict resolution and selection during cold tasks, i.e., with neutral emotional valence (MacDonald, 2008). Furthermore, research on the influence of reward monitoring and motivation on attention highlights the role of the nucleus accumbens (Pattij, Janssen, Vanderschuren, Schoffelmeer, & van Gaalen, 2007; Pezze, Dalley, & Robbins, 2007; Sarter & Paolone, 2011).

Paulsen, Hallquist, Geier and Luna (2015) conducted an important study assessing *inhibitory control* over prepotent responses of eye orientation (i.e., anti-saccadic movements) followed by aversive, rewarding or neutral stimuli. The role of different brain regions in task performance of children, adolescents and adults was assessed through fMRI. The authors found a predominant influence of developmental stage: the role of the ventral amygdala and of striatal activity on performance progressively diminished across adolescence, and more specific cortical areas were related to effective inhibitory control in adulthood, inclusively when facing neutral stimuli.

These results would agree with Eysenck et al.'s (2007) proposition that a stable emotional dysregulation (especially trait-anxiety) is likely to impair AC functioning in both *hot* and *cold* task demands. However, extensive research also relates developmental periods (e.g., Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Prencipe et al., 2011) and clinical conditions (e.g., Hobson, Scott, & Rubia, 2011; McNally, Shear, Tlustos, Amin, & Beebe, 2012; Zelazo & Carlson, 2012) with independent impairments in *hot* executive control.

An Integrative Neuropsychological Model of Attention

Ronald Cohen (1993) reviewed extensive literature on spatial, temporal, behavioral, neuroanatomical, physiologyical and phenomenological features of attention to propose a unified and integrative taxonomy of this complex phenomenon. He divided attention into four broad and sub-divisible components: (1) *sensory selection*, (2) *response selection and control*, (3) *attentional capacity* and (4) *sustained attention*. The updated taxonomy (Cohen, 2014), which reflects an integrated comprehension of attention, is presented in Table 1.

Table 1. *Neuropsychological framework of attention, from Cohen (2014, p. 940)*

Elements of attention	Components
Sensory selective attention	Orienting automatic shifts
	Filtering
	Selection (allocation and engagement)
	Focusing
Executive attention (response selection and control)	Intention
	Initiation
	Generation
	Inhibition
	Switching
	Higher-order executive control
Focused attention capacity	
Energetic factors	Arousal–activation
	Drive–motivation
	Affective state
	Effortful demands
Structural factors	Learning–memory
	Processing speed
	Temporal dynamics
	Spatial constraints
	Other cognitive resources
Sustained attention	Vigilance
	Fatigue
	Incentive–reinforcement contingencies

This taxonomy, when modeled (e.g., Figure 3), still reflects a temporal organization of attentional processes. During an initial stage of sensory selection, orientation and filtering occur according to salient stimuli and figure-background features, which are assessed by the interaction of sensorial systems with motivation-informational processes and response mediation to determine an increase or decrease in of *focus*. This results in a variation in the amount of information to be processed from a given channel or stimulus. Determining what is to be integrated and *selected* depends on a decision bias that is affected by expectations and previous experiences. In fact, even the early filtering process may be affected by previous experiences (e.g., priming), a *top-down* influence.

Automatic attentional engagement or shifting may occur as a result of *focusing* allied with the *orienting response* (OR), an initial orientation of the system towards new and salient stimuli that decays with habituation (Pavlov's "what is it" response). During experimental tasks, this decay is prevented by increasing the period between presentation of stimuli (Cohen, 2014). For example, orienting attention to the eyes of an individual that suddenly assumes an angry expression is an example of automatic attentional shifting. This depends on several stimuli features, as proposed by Titchener (1908).

Response intentions and active AC strategies, such as *active switching*, come into play at a later stage of selection. Unlike automatic shifting, *active switching* involves different strategies of exploratory search (e.g., visual tracking behavior) and specific neural networks, with the protagonism of the prefrontal lobe over the inferior/posterior parietal lobe and sensory-motor association areas (Cohen, 2014; Posner & Rothbart, 1998). Executive attention exerts an essential influence in response, as shown in Figure 3.

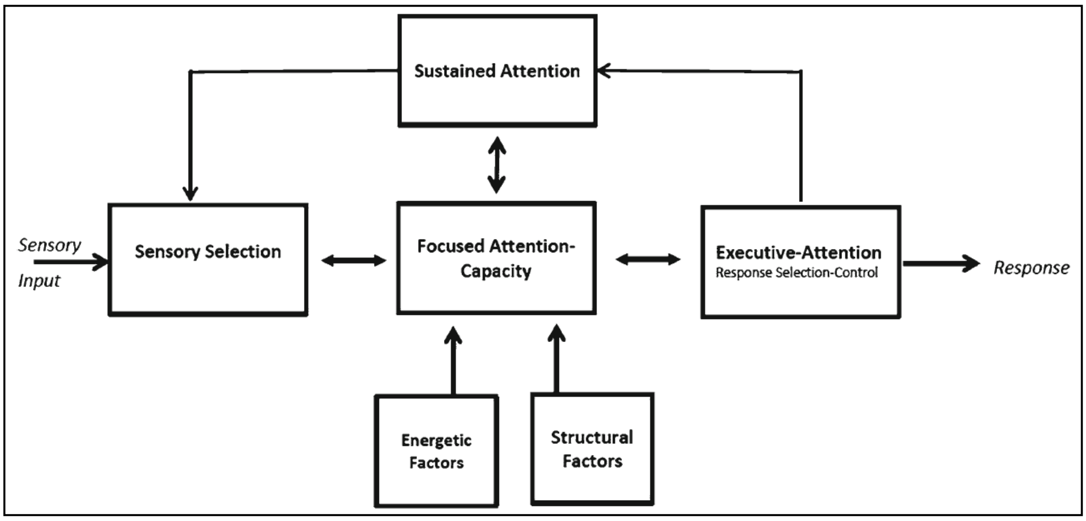

Figure 3. Elements of attention
Source: Cohen, R. A., 2014, *The Neuropsychology of Attention*, p. 945. Boston, MA: Springer US. doi:10.1007/978-0-387-72639-7

In Cohen's model, the interactions between bottom-up and top-down attentional processes as manifested in behavior are extensively and independently specified. It seems unlikely that this knowledge could be represented in a singular comprehensive graphical model with in-depth specification of independent structures. However, sample models of specific situations are provided by the author, such as in Figure 4, representing the early step of sensory selection of a given visual input.

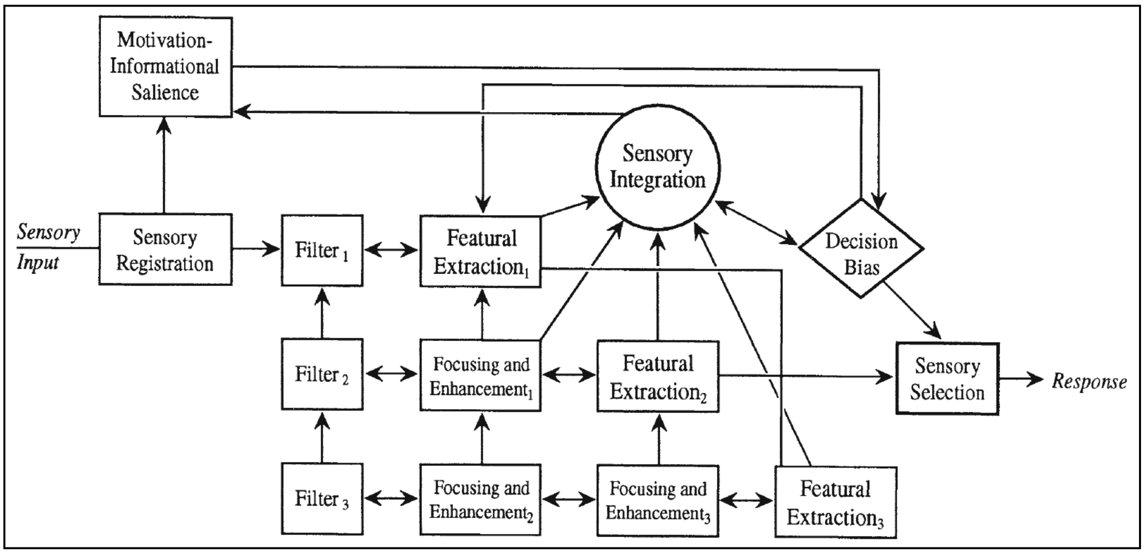

Figure 4. Interacting processes underlying sensory selective attention of exogenous visual stimuli

Source: Cohen, R. A., 2014, *The Neuropsychology of Attention,* p. 947. Boston, MA: Springer US. doi:10.1007/978-0-387-72639-7

Attentional Control Theory

In a fairly recent theoretical proposition, Eysenck et al. (2007) review the aforementioned models of attention, as well as Eysenck and Calvo's own Processing Efficiency Theory (1992), and focus on empirical data about emotional influences on attentional functioning. The Attentional Control Theory states that a high anxiety trait impairs performance in tasks demanding executive cognition, mainly because this trait hampers the ability (a) to *inhibit* automatic biases towards irrelevant stimuli (i.e., stimuli that do not contribute to goal-directed behavior) and (b) to alternate between stimuli – i.e., *active switching*. The overload imposed by anxiety on executive control may explain these AC difficulties. This means that not only AC has an important role in self-regulation, but is also heavily influenced by *emotional dysregulation*, which favors *stimulus-driven* processing and implicit biases towards threat. The use of compensatory effortful AC strategies is required in order to preserve goal-directed performance, what means trading efficiency for effectiveness (Eysenck & Calvo, 1992).

Therefore, impaired attentional functioning is not only seen as insufficient AC over implicit processes, but as an increase on automatic orienting to irrelevant stimuli (e.g., false indications of threat), an idea that is at the core of empirical work on ABT. Eysenck et al. (2007) state that *selective attention* performance is impaired in anxious individuals “more when task-irrelevant stimuli are threat-related rather than neutral. This should occur because anxious individuals are more responsive to threat-related distractors in a relatively automatic fashion via the stimulus-driven attentional system” (p. 346).

Together with previous ABT models (e.g., Beck & Clark, 1997), Attentional Control Theory has been utilized to explain the relationship between ABT and posttraumatic symptoms in individuals with PTSD (Schoorl, Putman, Van Der Werff, & Van Der Does, 2014) and in college students (Bardeen & Orcutt, 2011). In these studies, the relationship was mediated by the self-perception of stable AC difficulties, as measured by a self-report scale: the Attentional Control Scale (Derryberry & Reed, 2002).

Applications in Traumatized Samples

Classical posttraumatic symptoms such as intrusive trauma memories and hyper-reactivity to trauma cues may be understood as a dysregulation of the system that orients the organism to threat. Foa and Kozak (1986) postulated that an associative fear network forms in individuals with PTSD and that the activation of a nodule in this network results in the immediate activation of emotional, physiological and cognitive threat-related responses. Relationships between these domains are found in PTSD literature, e.g., a low heart rate variability (HRV) underlies the association between intrusion symptoms and poor EF in experimental and neuropsychological tasks (Gillie & Thayer, 2014).

Furthermore, experimental studies including target recognition with distracting threat-related stimuli show that individuals with PTSD tend to present specific performance characteristics, (a) responding faster when targets are congruent with threatening stimuli (i.e., facilitation bias), (b) requiring more time to reorient their attentional focus away from threat (i.e., disengagement bias) (Pineles, Shipherd, Mostoufi, Abramovitz, & Yovel, 2009) and (c) drawing their focus away from threatening stimuli, hindering target recognition (i.e., avoidance bias) (Bar-Haim et al., 2010; Cisler & Koster, 2010). These types of ABT are believed to be influenced by top-down and bottom-up attentional mechanisms (Eysenck et al., 2007).

Liberzon and Abelson (2016) reviewed neurobiological data about context processing in PTSD, implicating the heightened activation of a salience-orienting network in symptoms of hyper-reactivity. This network includes the dorsal ACC, the insula and the amygdala, and *orients attention* to threatening stimuli. This heightened activation may be related with a *bottom-up facilitation* bias to threat (Cisler & Koster, 2010).

Poor functioning of neural networks related to *executive control* and *self-regulation* (e.g., emotion regulation) were also implicated in the development and maintenance of PTSD symptoms, such as deficits in memory, biased attention to trauma cues, emotional reactivity, impulsivity and irritability. Such networks include the dorsolateral, ventrolateral and medial prefrontal cortexes (Liberzon & Abelson, 2016). It is possible that the dysregulation of these top-down control processes is related to the *AC impairment* that results in *disengagement* and *avoidance* biases (Eysenck et al., 2007). Cisler and Koster (2010) stated that the *avoidance* bias reflected a more strategic emotional response.

On the other hand, an inadequate generalization of the context of threat is related to the consolidation and recuperation of trauma memories *without* an adequate attribution of explicit contextual meaning (Brewin & Burgess, 2014). This is shown by incoherent activation of prefrontal and posterior (Reiser et al., 2014) and prefrontal and hypothalamic networks (Liberzon & Abelson, 2016). In accordance, studies indicate that different types of processing (i.e., verbal or non-verbal, explicit or implicit) during memory consolidation of a stressor may influence the development of posttraumatic symptoms (Holmes & Bourne, 2008; Holmes, James, Coode-Bate, & Deeprose, 2009). This means that the type of processing to which attentional resources are dedicated during and in the aftermath of trauma influences development of posttraumatic symptoms.

Specifically, verbal memory is believed to be impaired in individuals with PTSD, what may hinder the generation of a coherent narrative report of the traumatic experience (Schoorl et al., 2014). Thus, the emergence of intrusive memories may be related to an unbalance between orienting attention to verbal (e.g., semantic, declarative) and non-verbal (e.g., visuospatial) processes.

Attentional Bias and Attentional Bias Variability

A biased attentional processing influences orienting, selection and the amount of energetic focusing factors dedicated to potentially threatening stimuli and may be explained through the interaction of bottom-up and top-down attentional processes (Cisler & Koster, 2010). Disengagement bias is usually associated with an executive deficit in *inhibition* and *active switching* of attentional focus. Avoidance bias, on the other hand, is usually associated with a dysfunctional pre-attentive emotional regulation strategy (Eysenck et al., 2007). Again, response intention influences the early stage of sensory selection, shifting a person's focus to locations far from a threatening stimulus. As previously stated, these biases are likely explained by abnormal functioning of the dorsolateral, ventrolateral and medial prefrontal cortexes (Liberzon & Abelson, 2016). Regardless of which point of view is utilized to analyze ABT in PTSD, it is safe to assume that executive processes involved are usually acting on *hot* cognition.

Traditional tasks to asses ABT include distractors (e.g., threat words and pictures) that are (a) trauma or threat-related and (b) neutral, comparing reaction times of participants to target stimuli (i.e., probes) that are either congruent (appearing on the same location) or incongruent (at a separate location) with the threatening distractors, as well as comparing these response times with control presentations (e.g., trials with only neutral stimuli). Usually, classification is involved (e.g., deciding if the target is the letter E or the letter F) (Bradley, Mogg, Falla, & Hamilton, 1998; Schoorl et al., 2014).

To further improve analysis of ABT, an increasing number of studies include eye tracking technology as means of data collection, measuring fixations and saccades instead of keypress response latencies (for a meta-analysis, see Armstrong & Olatunji, 2012). Eye tracking allows for a more specific analysis, providing more spatial and temporal sensitivity – i.e., where is visual attention spatially directed to in different time points. This may allow researchers of ABT to better understand the interaction of bottom-up and top-down processes, in a chronological comprehension of the phenomenon (e.g., top-down functioning acting after automatic threat orientation). Still, a clear operational distinction between such processes in experimental tasks of ABT has not been achieved (Pergamin-Hight, Naim, Bakermans-Kranenburg, van IJzendoorn, & Bar-Haim, 2015), and reliability of eye tracking measures in such tasks may still be insufficient (Waechter, Nelson, Wright, Hyatt, & Oakman, 2014).

An example of this chronological comprehension is the vigilance-avoidance hypothesis by Mogg et al. (2004), which states that a facilitation towards threat *precedes* an avoidance bias away from threat in anxious individuals. Another example is the theoretical model of Yair Bar-Haim (Bar-Haim et al., 2007). This model (Figure 5) represents an application of previous attention research on threat detection and response generation, though it stems mostly of *empirical* findings which support both early automatic orientation towards threat (e.g., to subliminal threat stimuli presented for 17ms) and *control*-related biases (i.e., 500ms or more).

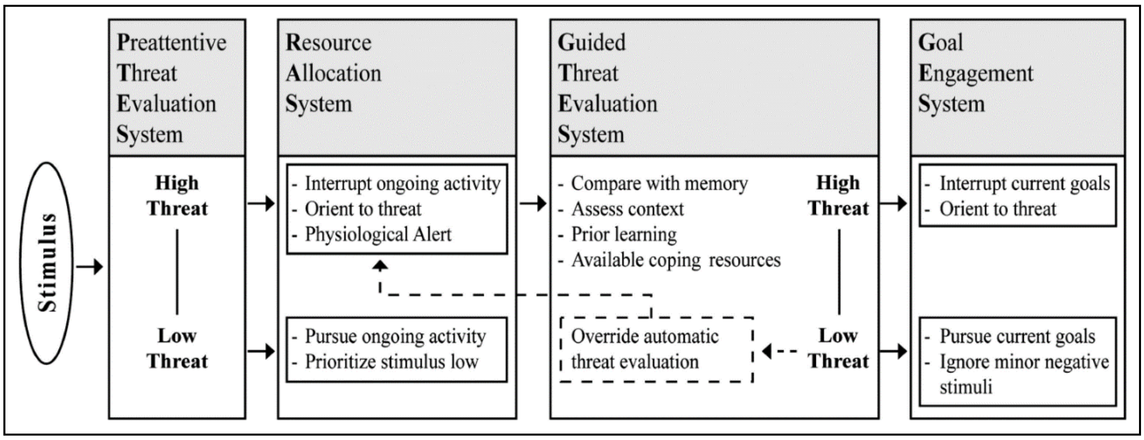

Figure 5. Cognitive processing model of attentional bias
Source:"Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study" of Bar-Haim et al.'s, 2007, *Psychological Bulletin*, *133*(1), 1–24. doi:10.1037/0033-2909.133.1.1

Anxious individuals may present impacts in any of the proposed stages of processing. In fact, aspects of the model are theoretically unclear, such as whether the *evaluation* that is said to occur at the PTES stage is purely stimulus-driven or may be influenced by preattentive motivational factors or priming. In this model, contextual and experiential factors come into play (in a more executive role) only during the guided threat evaluation system, already after a *decision* of interrupting an ongoing response set, which in turn happens at the same time as the orienting response. This is contrasting with the model by Cohen (2014) shown in Figure 4, and with evidence that experiential aspects (e.g., priming) may act even during filtering. Furthermore, Bardeen and Orcutt (2011) found that AC (as measured by the Attentional Control Scale) moderated the relationship between PTSD symptoms and ABT in shorter stimulus presentations (i.e., 150ms), what indicates that ABT may be even more influenced by AC in earlier stages of processing.

On the other hand, recent publications have discussed inconsistencies in ABT in experimental tasks, particularly in traumatized samples. Operationally, the facilitation and avoidance biases are opposite (i.e., faster vs. delayed allocation of attention to threat), but individuals with PTSD have presented both tendencies in ABT studies. Thus, these recent studies have focused on the analysis of variability of reaction times of an individual inside a given experimental task. This is called attentional bias variability (ABV). A high ABV may indicate a diffuse fluctuation between biases inside of the task, and appears to relate better to the development and maintenance of PTSD symptoms than specific biases (Badura-Brack et al., 2015; Iacoviello et al., 2014; Naim et al., 2015).

Attentional bias modification treatment

Currently, an intervention branch of experimental ABT research has emerged. Studies with attentional bias *modification* treatment (e.g., Schoorl et al., 2014) attempt to train anxious or traumatized individuals to re-orient their attention, remediating previously identified attentional biases. This is sought by creating a task in which target stimuli's locations are fixed, developing an *expectancy bias* opposite to threatening stimuli. Operationally, this is equivalent to promoting an avoidance bias in individuals who had presented a facilitation bias. Repetitive presentations of such a task are expected to reduce anxiety symptoms of anxious individuals (Bar-Haim, 2010). Alternatively, repetitions of balanced versions of the task (i.e., with equal frequencies of target congruency with neutral and threatening stimuli) is called *AC training* (Kuckertz et al., 2014).

Studies have attempted to verify how such trainings could be conducted in PTSD samples, reported to have high ABV between avoidance and facilitation. Iacoviello et al. (2014) found that both approaches were successful in reducing PTSD symptoms, however only *AC training* resulted in a lower ABV score, as well as greater PTSD symptom reductions than *attentional bias modification*. The latter result is opposite to what was found by Kuckertz et al. (2014). The ecological validity and the underlying reasons for these findings are unclear. It is not known whether such trainings actually promote executive AC functions, as the name *AC training* would imply, or if changes occur in automatic processes of selection and orientation to threat. Neither treatment changed ABT scores in the study by Iacoviello et al. (2014). Changes in PTSD symptoms may be therefore explained through different mechanisms.

Psychometric assessment

The influences of AC in PTSD are not investigated only through inferences in ABT studies and functional imaging of neuroanatomical networks. A traditional field of investigating executive control in PTSD is trough neuropsychological clinical tasks utilized to compare clinical and control groups. Individuals with PTSD usually present significant deficits relative to controls in *inhibition* and *cognitive flexibility* (or *set-shifting*) in tasks such as the Trail-Making Test, Color-Word Stroop and the Hayling Sentence Completion Test (Block & Liberzon, 2016; Koso & Hansen, 2006; LaGarde, Doyon, & Brunet, 2010). However, reports exist of no differences in performance in the same tasks between participants with PTSD and trauma victims without PTSD or non-traumatized controls (Flaks et al., 2014; Stein, Kennedy, & Twamley, 2002).

Discussion

A clearer definition of AC is made possible by differentiation of the constructs reviewed in this article. First, *attentional functions* or *behaviors* are those that act on perception and on different levels of information processing (e.g., filtering, focus, selection, inhibition) to orient the organism to internal and external stimuli, to resolve conflict and/or to promote accuracy and efficiency considering processing limitations. Some of these functions occur with no significant *awareness* or *volition* (i.e., they are automatic). Attentional functions that are determined by *volition* are the ones that constitute AC. When attentional functions result on awareness, a relationship with *consciousness* is established. The concept of *executive* attention, for example, implies an approximation of AC with awareness, though AC and executive attention are currently treated as synonyms. Awareness is currently seen as depending on attention, what is contrary to the early determinations of Wundt, who saw attention as a sensation, a *portion* of aware and conscious experience.

In clinical neuropsychological research, nomenclature of measured processes may vary depending on the background (i.e., clinical /psychometric or experimental) of the researcher. In strictly theoretical terms, EF captures more broadly all domains involved in most neuropsychological tasks, while AC is more specific to the core cognitive processing control functions usually determining performance on such tasks. This may be confusing for individuals entering the field of clinical neuropsychology, expecting to understand *which* function a test measures, and is still contrasting and unclear in all levels of scientific publications. This may be resolved in the future by the further integration of these areas, what is already happening for some time according to Cohen (2014).

The taxonomy and underlying attentional constructs of experimental studies is frequently unclear. Findings from empirical research in all domains of attentional research (e.g., experimental cognitive psychopathology, experimental neuroscience, clinical neuropsychology) have contributed to the development of complex integrative theoretical propositions (e.g., Cohen, 2014). However, these propositions are still poorly integrated with applied areas such as ABT research. Research on such areas is dependent of specific empirical models (e.g., Bar-Haim et al., 2007), which aid in integrating results from a wide range of studies, but obscure certain attentional constructs. For example, we believe that the explanation of *attentional bias modification* method as the generation of *expectancy biases* is a novel proposition from the present study. This highlights the need of integrating empirical models with previously established theoretical models through reviews and translational research.

In fact, research that breaches theoretical gaps in the understanding of such complex phenomena is currently being developed. An example is the association of neural networks with cognitive phenomena applied in ABT in PTSD samples, as proposed in the study by Block and Liberzon (2016). Still, classical findings such as the natural decay of the *orienting response* with habituation (Sokolov, 1963) seem obscured from ABT research. This decay may significantly impact tasks of facilitation bias assessment. Taking this into consideration may reflect in discussing such impact or even altering task designs (e.g., temporally spacing threat stimuli as to preserve the intensity of the orienting response).

Another constructive implication of the growing empirical findings of ABT research is the corroboration of previous AC models. For example, (a) the role of the SAS as mediator between perception, self-regulation and response selection (Norman & Shallice, 1986) *agrees with* (b) empirical research findings of Attentional Control Scale scores moderating the relationship between clinical PTSD symptoms and attentional biases in early sensory selection (Bardeen & Orcutt, 2011).

An interesting interpretation of ABT findings may be drawn from theoretical models of attention. Besides the heightened activation of a threat-orienting network (Liberzon & Abelson, 2016), which is essentially related to bottom-up processing, the *facilitation* bias may be explained by pre-attentional *expectancy biases* of individuals with PTSD. That is, the posttraumatic fear network (Foa & Kozak, 1986) may result in a predisposition of individuals with PTSD to orient towards threat. A possibly surprising interpretation is that, in terms of *attention*, this predisposition could be characterized as a functional *executive* process: an internal motivational factor influences the individual to set a decision bias in favor of processing certain stimuli features, that is, those related to previous memories of the trauma or of known threatening stimuli.

In Norman and Shallice's (1986) terms, the SAS would increase the activation value of threat-related schemas and favor associations with trauma memories, setting an *intention* prior to perception and facilitating appropriate response strategies (e.g., a fight-or-flight response). Naturally, this cannot be defined as healthy behavior, since it shows a problem of adequately identifying actual threatening situations. Distortions in other stages of executive processing may explains this, such as inadequate feedback over attentional strategies and dysregulated generation of expectancy biases. Still, it seems simplistic to attribute a *facilitation* bias only to (a) an intensification of (*bottom-up*) threat-detection networks or (b) weak *top-down* emotional regulation. Evidence already exists for an AC bias of proactive inhibition influencing early attentional orientation (e.g., Elchlepp, Lavric, Chambers, & Verbruggen, 2016).

If further supported by empirical evidence, this may explain the high ABV in traumatized samples as reflecting specific *trauma-related expectancy biases* instead of a general problem of executive AC or of orientation to threat, since both of the latter were found in anxious samples, but a high ABV was not. These trauma-related expectancy biases may be generalized to trauma-unrelated threatening stimuli. The difference of attentional allocation to both (a) general threat and (b) trauma-related stimuli in PTSD samples has been investigated (Pergamin-Hight et al., 2015). Empirical findings of attention-related research in trauma victims is accumulating.

This study aimed to clarify constructs involved in defining AC and its role in ABT, since confusion exists in current empirical studies. This was sought through a summarized historical overview of research on attention, followed by integrative models and their applications in empirical research on ABT. Besides clarification of aspects of AC and links between empirical findings and theoretical constructs, this review advances little in regard to understanding the underlying mechanisms of attentional phenomena (e.g., ABT and ABV). However, it stresses the importance of reviewing past models in order to design experimental tasks and interpret further empirical findings. A selection of reviewed definitions of attentional constructs is summarized on Table 2.

Table 2. *Constructs of attention and theoretical milestones*

Construct	Definition	Relevant studies
Supervisory Attentional System (SAS)	An AC mechanism with global influence over schemas of information processing, acting especially in unusual situations that demand control over automatic processes.	Norman & Shallice (1986)
Working Memory (WM)	A memory system composed of processing and buffering slave structures oriented and controlled by an attentional executive control system which may be defined as the SAS.	Baddeley and Hitch (1974) Baddeley & Andrade (2000)

Attentional Control (AC)	A set of volitional processes (often awareness-imbued, not always) that override or predispose processes of perception, information handling and response selection in order to resolve conflicts and orient processing towards goals. Includes attentional behaviors such as focusing, monitoring, inhibiting, switching and self-regulation. The minor attentional portion inside the broader area of executive function (EF).	Cohen (1993) Norman & Shallice (1986) Posner & Petersen (1990)
inhibitory control active switching	Essential AC functions that regulate the amount of resources directed to the processing of stimuli and determine response selection. Key to regulating automatic attentional biases.	Eysenck et al. (2007) Miyake et al. (2000)
Executive Function (EF)	Overlaps with AC though more comprehensive. Includes the behavioral end of response selection and decision-making, as well as additional higher-order processes (e.g., abstract reasoning), which rely on AC.	Miyake et al. (2000)
Attentional Bias towards or away from threat **(ABT)**	Differential allocation of attention between threatening and neutral stimuli during sensory selection, influenced by stimulus-driven (*bottom-up*) and top-down AC mechanisms. Traditionally assessed after late attentional stages of response selection (e.g., keypress reaction times), though more recent operationalizations exist (e.g., eye tracking).	Cisler & Koster(2010)
Facilitation	Facilitated (i.e., faster) engagement and orienting response to threat (implicit processes). Influenced by *priming* and *expectancy biases*.	Cisler & Koster (2010) Cohen (2014) Foa & Kozak (1986)
Disengagement	Difficulty (i.e., delay) of active shifting from threat to goal-relevant stimuli.	
Avoidance	Delay of active shifting from neutral to threat stimuli after initial threat engagement.	
Attentional Bias Variability (ABV)	Variability of ABT indices inside a given experimental task. Recent evidence indicates that high ABV (i.e., ABT fluctuation) is more related to the development and maintenance of PTSD symptoms than specific biases.	Badura-Brack et al. (2015) Iacoviello et al. (2014) Naim et al. (2015)

Orienting Response (OR)	The "what is it" reflex. Automatic engagement mechanism towards novel/threatening/salient stimuli. Generates automatic shifts combined with focusing and decays with habituation.	(Sokolov, 1963)
Priming	The induced/facilitated activation of a schema or orientation to a stimulus due to features of a previously processed stimulus.	(Posner et al., 1980)
Expectancy bias	Predisposition to orient to a stimulus or to activate a schema due to a favorable probability assessment.	
Attentional self-regulation **Effortful control**	Often interchangeable concepts relating to a temperamental faculty of regulation of internal drives and emotions, which affect attentional processes and response selection and interact with motivation and reward assessments.	Derryberry & Reed(2002) Paulsen et al. (2015) Rothbart et al. (2001)

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Empirical Article

Adaptation of a Dot-Probe Task with Eye Tracking and of an Emotional Stroop Task: novel indices and psychometric characteristics

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Abstract

Introduction: Experimental research on attentional bias relative to threat (ABT) is required to integrate new technologies (e.g., eye tracking) and to provide sustentation to theoretical models of attention. Reliability problems in such tasks have been reported. **Methods:** Two novel versions of traditional experimental tasks were developed. An Emotional Stroop Task (EST) and a Dot-Probe Task (DPT) with eye-tracking were utilized with 90 university students. Reliability indices (i.e., internal consistency, split-halves and test-retest) were investigated. Novel ABT and attentional bias variability (ABV) indices were calculated and compared between groups of high vs. low anxiety and posttraumatic stress symptoms. **Results:** Though pure reaction times (RT) and eye tracking measures were highly reliable, ABT scores were unreliable and indicative of poor validity, with certain exceptions. **Discussion:** ABT scores of eye tracking measures were as good or better than RT measures of ABT. Task designs and measurement problems are discussed in order to improve future research on the theme.

Keywords: attentional bias; attentional bias variability; Dot-Probe; Emotional Stroop; eye tracking.

Introduction

Groups of individuals with high trait anxiety have shown an attentional bias towards or away from threat (ABT) in many studies utilizing adaptations of the Dot-Probe (DPT) and the Emotional Stroop tasks (EST) (Bar-Haim et al., 2007; Cisler & Koster, 2010). Other individuals, such as those who suffer with posttraumatic stress symptoms (PTSS) and posttraumatic stress disorder (PTSD), present conflicting patterns of ABT, what has led current research to the analysis of an attentional bias variability index (ABV) in traumatized samples (Badura-Brack et al., 2015; Iacoviello et al., 2014; Naim et al., 2015).

Empirical models were developed to account for the underlying attentional phenomena that may explain such results. However, established theoretical constructs of attention and attentional control (AC) seem left out of experimental research, and task design adaptations to new technologies (e.g., eye tracking) are in order. This study tested adaptations of the two most utilized tasks in ABT research, investigating their psychometric properties and analyzing groups with different degrees of trait anxiety and PTSS.

The Emotional Stroop Task

The EST comprises several widely utilized adaptations (Williams, Mathews, & MacLeod, 1996) of the original Color-Word Stroop task (Stroop, 1935). The EST usually consists in identifying the color printed in serially-presented written words, which can be of neutral or emotional (e.g., threat-related, trauma-related) content. The difference in reaction times (RTs) between emotional and neutral words provides a measure of attentional bias (Bar-Haim et al., 2007). As stated by Algom, Chajut and Lev (2004), the original Stroop task and the EST share little of the underlying mechanisms that explain this delay in RTs. The EST, especially when utilized with threat words, does not rely on the Stroop effect – i.e., an overload of interference control mechanisms due to conflict of incongruent features, such as color word (e.g., the word *blue*) vs. color (e.g., the word printed in *red*). Instead, threat versions of the EST appear to rely on other attentional mechanisms of threat orientation, which demand attentional processing and may hinder alternate task demands (e.g., color naming).

This difference leads to the consideration of other attentional processes and demands. For example, recent theoretical models of attention (e.g., Cohen, 2014) state that sensory and response selection are highly dependent on both volitional regulatory (*top-down*) and automatic (*bottom-up*) mechanisms. Constructs that are common in experimental threat paradigms need to be considered, such as the *orienting response*, an automatic attentional engagement on novel or threatening stimuli – which Pavlov named the "what is it" response (Sokolov, 1963). The orienting response is intimately related with an automatic focusing mechanism and is reported to naturally decay with habituation (Cohen, 2014), what may be prevented in experimental tasks relying on orientation to threat words by providing more time between novel or threatening stimuli.

The activation of threat-detection neural networks of early attentional engagement has been closely related with a *facilitation* bias (Block & Liberzon, 2016). Furthermore, different attentional networks have been related with AC mechanisms acting on either hot (e.g., threat processing) or cold (e.g., interference control in the original Color-Word Stroop) cognitive processes (Block & Liberzon, 2016; M I Posner & Rothbart, 1998). Differences also exist in "hot" networks related to *threat-processing* and emotional *self-regulation* (MacDonald, 2008), what may be relevant to studies utilizing threat paradigms in emotionally dysregulated individuals.

A meta-analysis by Phaf and Kahn (2007) indicated that the mechanism that is most likely involved in performance on the EST is a “slow” disengagement from threat problem, which may cause delayed RTs *after* the presentation of the threat-related stimulus. Disengagement problems, when compared to early facilitation to threat, may be more related to a failure in active AC mechanisms (Eysenck et al., 2007; Liberzon & Abelson, 2016). According to Eysenck et al. (2007), the heightened activation of threat-orienting networks would induce *stimulus-driven* processing (i.e., facilitation towards threat). In the EST, this processing would focus on representations associated with the threat word, which are very unlikely to contribute with color naming. Thus, the interpretation of a *facilitation bias* as fast RTs in the EST would likely be inappropriate.

In fact, a combination of *facilitation* towards threat and difficulty to actively *inhibit* threat processing appear to interact to explain ABT in the EST (Eysenck & Derakshan, 2011). The question remains if non-anxious individuals are better at (a) *inhibiting* threat-processing due to an early stage task-oriented AC bias, (b) actively switching or *disengaging* from a prepotent threat processing at a later stage, (c) *inhibiting* general sources of emotional activation that may cause interference, such as trait anxiety – i.e., self-regulation (MacDonald, 2008) or (d) a combination of the above (Bar-Haim et al., 2007).

We hypothesized that separating the presentation of threat words in different blocks of threat-neutral trials would better preserve the *orienting response* and result in a heightened overall RT to threat relative to neutral words. Furthermore, separation of the EST in trials enables a simple calculation of attentional bias variability across the task. On the other hand, we instructed the participant to actively ignore threat-related word content, what we hypothesized would enhance a prior response intention to favor *task demands*, biasing AC towards the initial *inhibition* of threat (e.g., Elchlepp, Lavric, Chambers, & Verbruggen, 2016). Thus, a heightened RT to threat words would be more closely related to difficulties in self-regulation (of anxiety) or in disengaging from threat.

We investigated the reliability of this novel task to guarantee that any findings would not be influenced by psychometric limitations. Besides being a novel adaptation, previous studies have reported unacceptably low reliability of the EST regarding ABT scores (Ataya et al., 2012; Brown et al., 2014; Eide, Kemp, Silberstein, Nathan, & Stough, 2002; Strauss, Allen, Jorgensen, & Cramer, 2005) or have failed to differentiate groups of high and low trait-anxiety (e.g., Brown et al., 2014; Fava, Kristensen, Melo, & Araujo, 2009; Melo, Peixoto, Oliveira, & Bizarro, 2012).

The Dot-Probe Task

The DPT is at the center of ABT research for more than a decade (Bar-Haim et al., 2007; Cisler & Koster, 2010). This paradigm consists in the simultaneous presentation of threat-related stimuli (e.g., angry faces, threat words, trauma-related images) and neutral stimuli on opposite locations of a screen followed by a target stimulus (i.e., a probe) which requires classification (what is it?) or spatial identification (where is it?). All of these events constitute a trial, usually ended when a response occurs. A number of trials inside a DPT may include neutral stimuli only, serving as controls for the *threat* (or experimental) trials (Price et al., 2015). A significant difference between RTs across threat and control trials indicates that an ABT occurred. (Bar-Haim et al., 2007; Cisler & Koster, 2010).

Specific ABT scores are usually obtained from (a) the difference between RTs across incongruent trials (i.e., in which the probe appears at the location previously occupied by a neutral stimulus opposite to threat) and congruent trials (i.e., in which the probe is preceded by a threat stimulus) *or* (b) from the difference between RTs across incongruent or congruent threat trials and neutral trials (Koster, Crombez, Verschuere, & De Houwer, 2004). The higher the index obtained from the first strategy (a), the faster the RTs towards threat are (i.e., *facilitation* occurred) *or* the slower the RTs away from threat are (i.e., *disengagement* was delayed) (Cisler & Koster, 2010). A negative index indicates slower responses to threat relative to non-threatening stimuli – i.e., threat *avoidance* – or fast *disengagement* – have probably occurred (Mogg et al., 2004).

The second strategy (b) allows for clearer differentiation of *facilitation* and *disengagement* biases (Price et al., 2015). If a higher index is obtained from RTs across *control* (i.e., neutral-neutral) trials minus *congruent* trials, the individual has responded faster to threat (i.e., facilitation). If the difference between *incongruent* trials and *control* trials is positive, RTs were slower when probes were away from threat, what indicates a delay in *disengagement* from threatening stimuli. An interesting problem is that both indices, if negative, could be interpreted as an *avoidance* of threat – i.e., slower RTs to threat and faster RTs away from threat. The operational confusion is obvious (this is also mentioned by Price et al., 2015). *Avoidance* and *disengagement* biases are therefore still diffusely operationalized in RT measures on different versions of the DPT.

Biases towards threat are likely to be influenced by attentional processes on several stages of processing (e.g., as proposed in the model by Bar-Haim et al., 2007). A facilitated engagement on threat has been identified even in subliminal stimuli presentations (e.g., 17ms), though disengagement – and especially avoidance – are presumed to suffer AC influences from later stages of attentional processing (e.g., 500ms) (Bar-Haim et al., 2007; Cisler & Koster, 2010)

Furthermore, results of ABT measurements are unclear in PTSD populations. The fluctuation of traumatized samples between types of ABT has led researchers to investigate the novel index of attentional bias variability (ABV), which has been reported to be significantly higher in individuals with PTSD. (Badura-Brack et al., 2015; Iacoviello et al., 2014; Naim et al., 2015). This index is calculated by dividing trials into sequential blocks (e.g., 8 blocks of 20 trials each) and obtaining a standard deviation from the ABT mean of each block. This result is then divided by mean RT across all trials to correct for variance (Iacoviello et al., 2014). We propose a novel approach to calculating ABV, which encompasses the possibilities of analysis provided by eye tracking technology. The adapted version of the DPT in this study focuses on two possible stages of processing (i.e., of early threat engagement *vs.* higher AC goal-oriented influences), with a higher specificity in the identification of types of ABT also made possible by eye tracking.

Psychometric characteristics of this novel DPT are investigated, since this complexification of the task may result in an array of measuring problems. Furthermore, reliability problems in other versions of the DPT have been recurrently reported (Ataya et al., 2012; Brown et al., 2014; Dear et al., 2011; Kappenman et al., 2014; Price et al., 2015; Schmukle, 2005; Staugaard, 2009; Waechter et al., 2014).

Eye Tracking and the DPT

Eye tracking has been utilized as a means to increase temporal and spatial sensitivity in experimental measures, and to move beyond ABT interpretations that spawn from RTs (Armstrong & Olatunji, 2012). For example, a classical study by Pflugshaupt et al. (2005) identified that anxious individuals were prone to stare away from (i.e., *avoid*) phobic stimuli in a visual search task after an initial fixation (i.e., facilitation) period on the threat, as compared to non-anxious controls. Identifying that the individual orients attention away from the target probe (and from threat) is much easier when a clear indication of overt attentional behavior (e.g., gaze direction) is provided.

Eye tracking technology has been utilized for more than a decade to measure ABT, and its reliability has been investigated alongside with that of tasks such as the DPT (e.g., Waechter et al., 2014). Surprisingly, only a handful of studies have united the Dot-Probe paradigm with eye tracking technology, investigating their convergent validity by comparing RTs with gaze fixation measurements *during* a DPT (e.g., Mogg, Garner, & Bradley, 2007; Price et al., 2015; Yang, Jackson, Gao, & Chen, 2012). To our knowledge, only Price et al. (2015) investigated the reliability of this proposition, finding results similar to measuring ABT only with RTs.

This integration of keypress responses and gaze direction measurement is attempted in the present study. We hypothesize that maintaining the threat stimuli (i.e., pictures of faces) simultaneously with probe presentation will aid in clarifying ABT with the use of eye tracking. Along with specific operationalization of types of ABT, we divided each DPT trial into (1) a free visualization period to investigate *facilitation* bias with eye tracking, what is usual in eye tracking studies (Armstrong & Olatunji, 2012), and (2) a more AC-demanding period of probe classification when *disengagement* or *avoidance* problems are more likely to occur, while images remain on display to enhance eye tracking sensitivity.

This study therefore investigates propositions that have been recommended for more than a decade, such as in the conclusion of Bar-Haim et al.'s (2007) influential meta-analysis:

> First, there is a need for more refined investigation of the different stages of information processing in which anxious and non-anxious people differ. This calls for new experimental setups […], for the use of other outcome measures in addition to manual reaction time and accuracy (e.g., response variability), and for reliance on technologies that allow one to go beyond observed behavior in order to index the timing of specific cognitive processes (e.g., eye tracking, event-related potentials [ERPs]). (p. 18)

Methods

Participants

A total of 103 adult university students were assessed for eligibility. Exclusion criteria were the presence of (1) a history of psychotic symptoms, (2) a current major depressive episode (a score of 13 or more on the PHQ-9), (3) an ADHD diagnosis and (4) any uncorrected visual perception problem (e.g., myopia, color blindness). Task-related exclusion criteria are explained on the *procedures* section, and a flowchart of all exclusions is presented in Figure 6. Characteristics of the 90 participants assigned to the experimental tasks are described on Table 3. All participants were recruited through flyers in the campus of a private university in Brazil and through posts on digital social media. Course credit was offered as compensation for participation. The statistical power to detect a true correlation (Pearson's *r*) of at least .70 with a significance level (α) of .05 was higher than .99, considering both a sample of 90 and of 40 participants.

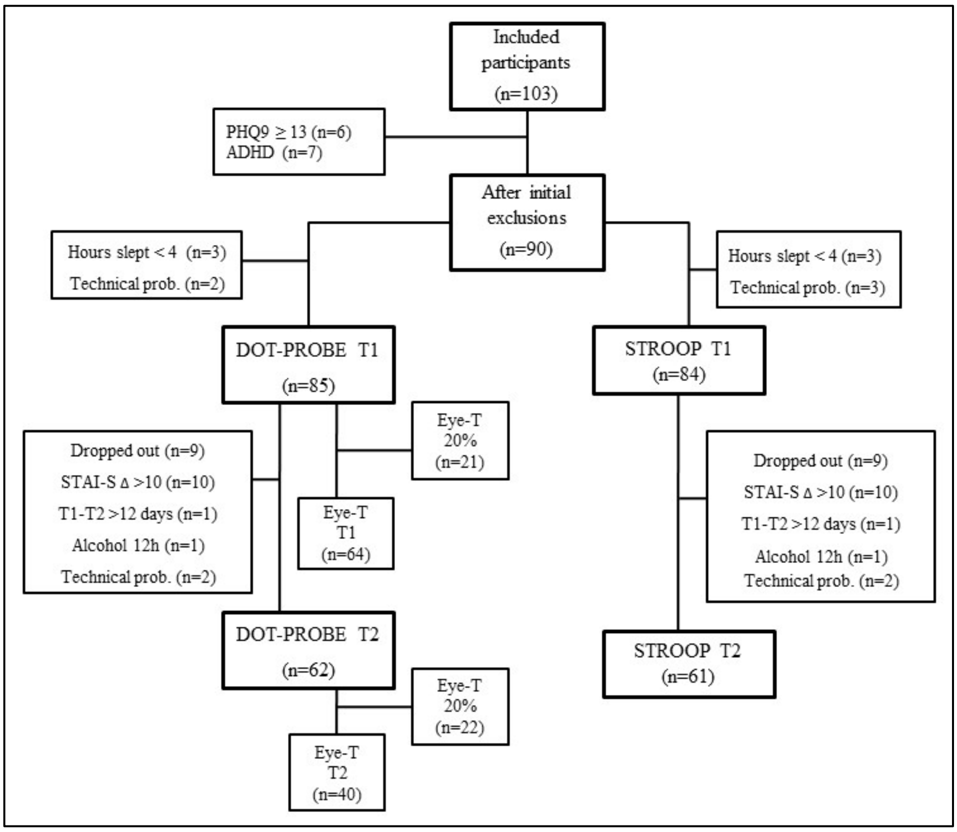

Figure 6. Flowchart of exclusions and dropouts

Note: The *Eye-T* T1 and T2 boxes include all participants whose measures were utilized in gaze fixation analyses – a subsample of DPT T1 and T2 samples. The *Eye-T 20%* criterion is explained in the data analysis section, and task-related exclusions are explained in the procedures section.

Table 3. *Sample characteristics*

	n (%)	*M* (*SD*): range
Sex		
female	54 (60)	
male	36 (40)	
Age (years)		22.81 (5.06): 18-48
Ethnicity		
White	85 (94.4)	
Black	4 (4.4)	
undeclared	1 (1.1)	
Socio-economical classification*		
high	38 (42.2)	
high average	38 (42.2)	
average	14 (15.6)	
Years of study		15.24 (2.65): 10-22
Manual dominancy		
right	72 (80)	
left	16 (17.8)	
both	1 (1.1)	
Medication intake		
antidepressants	10 (11.1)	
other	6 (6.7)	
Medical disorder		
ophthalmological	39 (42.9)	
neurological	5 (5.5)	
psychiatric		
MDD	11 (12.1)	
GAD	6 (6.7)	
other anxiety	2 (2.2)	

Note: MDD= Major Depressive Disorder, GAD= General Anxiety Disorder
*according to Brazilian standards (IBGE)

Instruments

Questionnaires

Sociodemographic sheet – designed to investigate sample characteristics such as sex, years of study and medical disorders. Also includes questions investigating exclusion criteria for experimental tasks, such as recent alcohol and caffeine consumption and hours of sleep.

Attentional Control Scale (ACS) – Derryberry and Reed (2002), Brazilian adaptation by Filgueiras et al. (2015) – questionnaire assessing self-perception of automatic and voluntary abilities of attentional control. Has 20 items (e.g., "I have a hard time concentrating on a difficult task when there is a lot of noise around me") on a 4-point Likert scale. A good internal consistency was reported in the original ACS (Cronbach's $\alpha = 0.88$).

Patient Health Questionnaire (PHQ-9) – Kroenke, Spitzer and Williams (2001), adapted by Fraguas et al. (2006) - questionnaire with 9 items in a 4-point Likert scale investigating the severity of depression symptoms in the past two weeks, according to diagnostic criteria for DSM-IV Major Depressive Disorder. Satisfactory indicators of reliability were found for the PHQ-9: Cronbach's $\alpha > 0.8$ and a strong test-retest correlation ($r = 0.84$, $p <0.01$) (Kroenke, Spitzer, Williams, & Löwe, 2010)..

PTSD Checklist (PCL-5) – Weathers, Marx, Friedman and Schnurr (2014), adapted by Lima et al. (2016) – self-report scale that indicates the severity of posttraumatic stress symptoms (PTSS) and provides a diagnostic measure of PTSD. The 20 items in a Likert scale from 0 to 4 points correspond to all PTSD symptoms identified in the DSM-5 (American Pychiatric Association, 2013). Internal consistency of the scale was reported to be high ($\alpha = 0.96$) (Bovin et al., 2015). Participants without an A1 traumatic event featured on PTSD diagnosis (APA, 2013) were asked to fill the questionnaire according to the most stressful life event they had experienced, however only PCL-5s of participants with an A1 event ($n = 52$, 57.78%) were analyzed in this study.

The State-Trait Anxiety Inventory (STAI-S and STAI-T) – Spielberger, Gorsuch and Lushene (1970), adapted by Biaggio, Natalício and Spielberger (1977) – two sets of 20 assertions measuring (a) current state of anxious response tendencies and (b) steady self-regulation problems and patterns of excessive concerns. Each scale generates a total score between 20 and 80 points. In this study, STAI-S was utilized to investigate acute differences on state-anxiety between experimental sessions and STAI-T differentiated anxious from non-anxious individuals.

Software and apparatus

Participants' head movements were limited by a *chin rest* supported on a steel bar with adjustable length. An industrial earmuff was utilized in order to provide acoustic isolation. A Dell Inspiron 14R 3650 laptop with 6 GB of RAM and an Intel Core i5-3337U processor was utilized to run the experimental tasks. The open source software Ogama (Open Gaze and Mouse Analyzer) (Voßkühler, Nordmeier, Kuchinke, & Jacobs, 2008) was utilized to design, run, record and extract data from both tasks. Visual display occurred on a 17" monitor with 1024 x 768 resolution, which required a 60Hz HDMI to VGA converter to receive video transmission from the laptop (plus HDMI 2.0 and VGA cables).

The eye tracker was positioned below the monitor on a tripod, similarly to the setup proposed by Ooms, Lapon, Dupont and Popelka (2015). The distance from participants' eyes (a) to the center of the screen and (b) to the eye tracker, which was often slightly moved to increase calibration quality, were approximately (a) 67cm and (b) 48cm. These distances depended on the height of each participant's eyes relative to their chin.

Experimental tasks

The adapted Emotional Stroop Task (EST) – modified from Stroop (1935) and from other EST designs, such as Williams et al. (1996) – participants were required to indicate (through a set of three colored keys on the keyboard) the color in which sequentially appearing words were written. Words were selected from the Brazilian Portuguese adaptation of the Affective Norms for English Words (ANEW) (Fava et al., 2009). A total of 40 threat words were selected from those with Self-Assessment Manikin (S.A.M.) scores of higher arousal (at least 5, M = 6.37, SD = 0.56) and lower valence (no higher than 3, M = 1.86, SD = 0.43). The 136 neutral words were selected from those with low arousal (no higher than 4, M = 3.42, SD = 0.41) and medium valence (between 4 and 6.50, M = 5.42, SD = 0.65). Only words within the range of 5 to 8 letters were selected.

The task comprises 40 trials of 4 words each (1 threat and 3 neutral) and is preceded by written instructions and by 4 trials of training (each with 4 neutral words). Participants were alerted that a number of words in the task had been considered threatening by others, but that they should ignore written content and focus on identifying colors (i.e., green, red or blue). The trials were organized so that words inside each trial had the same number of syllables and a size variation of no more than one letter. Color attribution was controlled so no more than one color repetition occurred in each trial. Letter cases are 40 pixels high.

The sequence of trials and the positioning of words inside each trial are randomized on every task presentation (as show in Figure 7). In-trial events are (1) a fixation cross for 500ms, followed by (2) the first word, until keypress, immediately followed by the second word and so on, until the keypress response for the fourth word; (3) blank slide for 1000ms and (4) next trial.

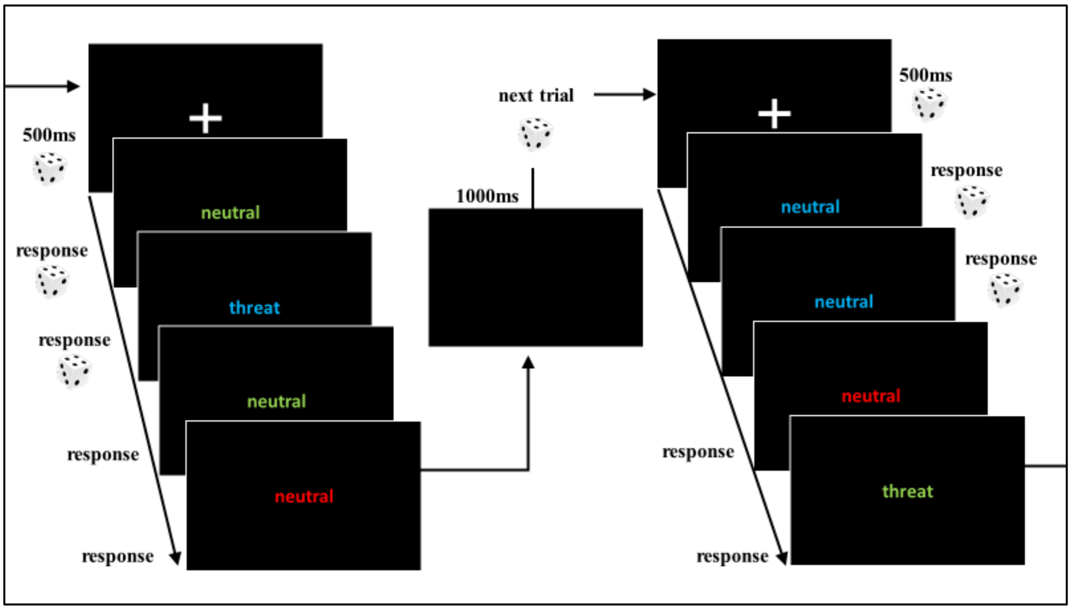

Figure 7. Trial sequence of the adapted EST

Note: dice represent the randomization of following events. The inter-trial intervals including blank and fixation slides were expected to preserve the intensity of the *orienting response* to threat words.

The adapted Dot-Probe Task (DPT)– MacLeod et al. (1986), based on designs as proposed by Iacoviello et al. (2014), Schoorl et al. (2014) and Bradley et al. (1998) – this task consists of 120 consecutive trials (80 *threat* trials and 40 *control* trials) preceded by written instructions and 6 trials of training with probes only – no pictorial stimuli. In-trial events are (1) a fixation cross for 500ms; (2) a pair of pictorial stimuli (i.e., faces of models) for 800ms on the left and right extremities of the screen and vertically centralized – free visualization; (3) the same pair of faces, though with the onset of the probe, i.e., a colored (green or blue) target ellipse 190 pixels wide and 240 pixels high centered on one pictured model's head until a keypress response; and (4) a blank slide for 1000ms preceding the next randomized trial (as shown in Figure 8).

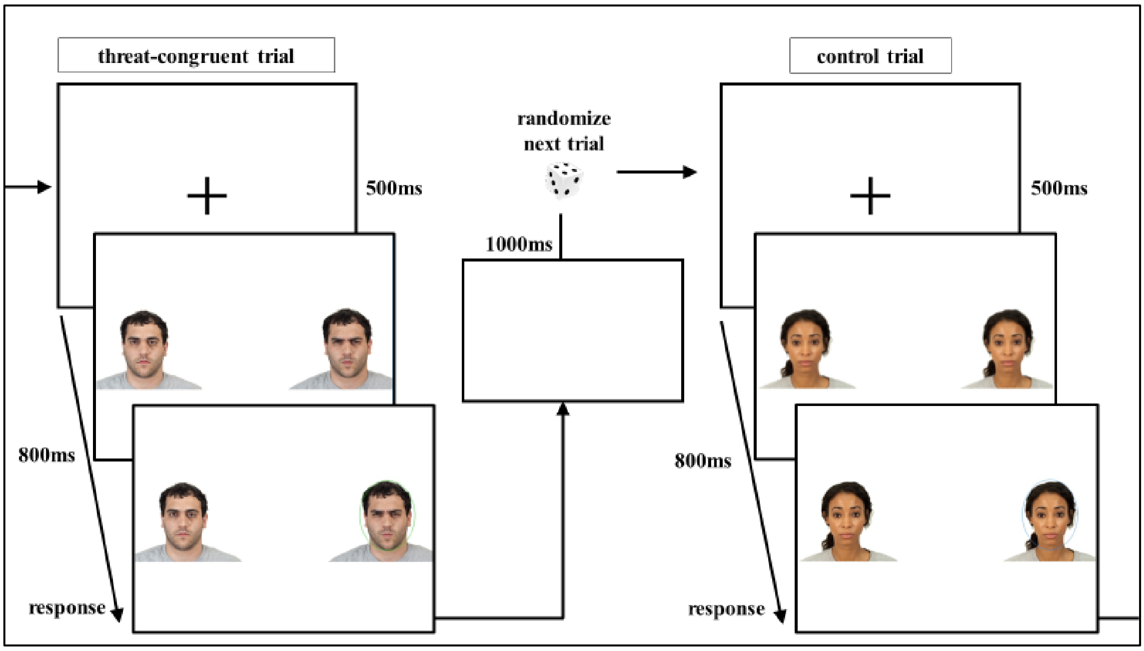

Figure 8. Trial sequence of the adapted DPT

Note: the preservation of images after probe onset is expected to increase stimuli-oriented fixations.

Each pair of faces was either (a) an angry (threatening) and a neutral (non-threatening) expression of the same model or (b) two equal images of a neutral expression. Each model appeared only once on each task presentation (i.e., one model was selected for each trial). Threat trials included a balanced number of congruent trials (i.e., those with the probe appearing over an angry face) and incongruent trials, as well as equal distributions of models' ethnicity (either Black or White) and gender (man or woman). Faces were selected from the Chicago database (Ma, Correll, & Wittenbrink, 2015).

Written instructions informed participants that the objective of the task was to correctly identify the color of the ellipses by pressing the corresponding key (which had either a green or blue patch) as fast as possible. The participant was encouraged to practice and memorize the color of each key during training. After training, new instructions informed participants that pictures of faces would appear prior to the ellipses and that such faces were to be ignored for the remaining portion of the task.

Participants were asked to refrain from looking away from the screen and towards the keyboard from that point on. Eye tracking measurements were collected throughout the task.

Eye tracking

The *Eye Tribe Tracker - Development Kit* was utilized to detect gaze direction during the DPT. Although this tracker has a lower sampling rate than its more traditional counterpart, the SMI RED 250, the Eye Tribe's accuracy has been shown to be satisfactory in studies in which both trackers were compared (Ooms et al., 2015; Popelka, Stachoň, Šašinka, & Doležalová, 2016) – except for problems reported when gaze was directed to the *bottom* of the screen (Popelka et al., 2016). Such problems led us to choose to present pictorial stimuli bilaterally on the DPT instead of the most utilized vertical presentation (Price et al., 2015). The Eye Tribe was reported to generate satisfactory accuracy when used in conjunction with the Ogama software (Ooms et al., 2015).

Eye tracking data was recorded at a frequency of 60Hz. Eye movements of at least 83.50ms within a 1º visual angle were considered a *fixation* (a minimum of 5 coordinate samples of 16.70ms). The center of both images in a DPT trial (i.e., the central point between models' eyes) was 23cm apart (see Figure 9). Taking the distance between the participant and the screen (67cm) into account, this results in a *visual angle* of approximately 19.5º between the center of the images, and 28.5º between the extremities of the screen. Two areas of interest (AOIs) were included in each trial. AOIs were circles of 300 pixels of diameter centered around the heads of models portrayed in pictorial stimuli. The *total fixation time* inside each AOI was the chosen measure of gaze orientation to each respective face.

Figure 9. *AOIs in an incongruent threat trial of the DPT*

Note: the AOI larger circles were not visible during task presentation, only the probe (blue ellipse). On this case, the trial is *threat-incongruent* and the face on the right (threat) is *probe-incongruent*.

Procedures

Data were collected between July 3rd and November 6th, 2017. All participants were required to contact the research team through e-mail. Information regarding procedures was provided in reply. Participants were asked to prepare for two sessions (i.e., T1 and T2) seven days apart from one another and to refrain from (1) benzodiazepines, alcohol, marijuana or other psychoactive substances in the 24 hours previous to both sessions, (2) methylphenidate or other attentional regulation medication on the day of the sessions, (3) caffeine or nicotine in four hours prior to the sessions and (4) wearing contact lenses (glasses were recommended instead) or mascara, since these were reported to interfere with gaze detection (Holmqvist, K. et al., 2011).

Participants who ignored any of these requests were asked to return at a new date (when at T1) or were excluded from test-retest analysis (when at T2). Reminders of these combinations were sent by e-mail on the day before both sessions, which occurred on a 2m x 3.20m room with controlled temperature at the university campus.

On T1, participants were greeted by one of the research staff members, who presented a signed consent form, reviewed procedures, answered any remaining questions and proceeded to handing out all questionnaires to the participant. The experimental tasks followed, always beginning by the DPT. This was decided in order to preserve the eye tracking data. Furthermore, since the DPT only required identification of two colors, instead of three as in the Stroop task, participants would begin with an easier set to memorize. This was expected to reduce the effect of poor learning on performance.

The participant's seat was adjusted until a comfortable relative height to the chin support was established (i.e., the relative distance between the chin support and the monitor was maintained). General instructions were given before each task, especially for the participant to refrain from talking or moving his head after the task initiated. Eye tracking 9-point calibration occurred until a *good* or *perfect* calibration indication was achieved (this often required moving the tracker). The DPT was then initiated. The researcher sat to the left of the participant, on the extreme left side still inside the participant's field of view. The participant was encouraged to move, rest and talk to the researcher for approximately 5 minutes in between tasks (the time for data to be stored on the software at the end of the first task). The chin support and eye tracker were not utilized on the Stroop task, which began after new written instructions. T1 had a duration of approximately 50 minutes.

On T2, participants were asked once again to answer the STAI-S and a set of questions to investigate task exclusion criteria. Participants who presented score variations on the STAI-S higher than 10 points (STAI-S $\Delta > 10$) were excluded from test-retest analyses. This range was determined by examining outliers in our sample. Participants with an interval of more than 12 days between T1 and T2 were also excluded. Both experimental tasks were then performed, with the same procedures as in T1. The presentation order of experimental trials inside both tasks was randomized in each session. The opportunity of receiving feedback about the questionnaires was offered to all participants, and those who asked to see the results of the research were put on a list, so that publications of the research could be provided. T2 had an approximate duration of 25 minutes. Participants who had significant scores on the PHQ-9 and PCL-5 were contacted for reference to psychological services. None of the participants reported being significantly disturbed by the task.

Data Analysis

Error rates, RTs and gaze fixation durations were utilized to calculate indices of psychometric reliability. Classical RT-based ABT indices were calculated inside the DPT by (a) subtracting mean RT on threat-incongruent trials from mean RT on threat-congruent trials (threat congruent – threat incongruent) and by (b) subtracting mean RT on control trials from mean RT on threat-incongruent trials (threat incongruent – control). In the EST, mean RT to neutral words was subtracted from mean RT on threat words. In both tasks, the *accuracy* ABT index was calculated by subtracting mean errors on neutral events (control trials in the DPT and neutral words in the EST) from mean errors on threat events (threat trials in the DPT and threat words in the EST).

In the DPT, specific in-trial ABT indices were also calculated utilizing total fixation times. A vigilance-avoidance (Mogg et al., 2004) *facilitation* index was calculated at the free visualization period as the total fixation time on the threat face of the trial *minus* the total fixation time on the neutral face of the same trial. Both the *disengagement* and *avoidance* indices were calculated with fixation times *after* probe onset. The *disengagement* index was calculated from the difference between fixation time on a probe-incongruent threat face *minus* mean fixation time on equivalent probe-incongruent faces on control trials (e.g., fixation time on threat face on the right with probe on the left – mean fixation time on controls on the right with probe on the left). Finally, an *avoidance* index was calculated as the difference between fixation time on a probe-incongruent neutral face on a threat trial *minus* mean fixation time on its probe-incongruent equivalent in control trials (e.g., fixation time on neutral face on the right with probe on the threat face on the left – mean fixation time on controls on the right with probe on the left).

The group effects of high vs. low trait anxiety (cut-point of 40 on STAI-T scores) and PTSS (cut-point of 9 on the PCL-5) on all indices of ABT were investigated through ANOVA. Paired samples *t*-tests were utilized to differentiate measures of attention dedicated to threatening vs. neutral stimuli. The relationship of ABT indices with trait anxiety, attentional control and posttraumatic symptoms was investigated through bivariate Pearson correlations with STAI-T, ACS and PCL-5 scores.

The calculation of ABV in both tasks was based on *in-trial* ABT indices, instead of ABT indices relative to blocks of trials (e.g., Iacoviello et al., 2014). This was relatively simple on the EST: the RT to the single threat word on a trial can be subtracted from the mean RT of the three remaining neutral words, generating the in-trial ABT index. The standard deviation from ABT indices across all trials is calculated and divided by mean RTs to correct for variance, resulting in the ABV index.

On the DPT, two in-trial ABT indices based on eye tracking measures were utilized to calculate ABV. First, the *facilitation* bias index was utilized to calculate ABV in the *free visualization* period (FV-ABV). The standard deviation of all in-trial facilitation indices was divided by mean fixation time on all faces to generate the FV-ABV.

However, after probe onset, threat trials became differentiated for being *threat congruent* or *incongruent*, what demanded extra effort to generate a post-probe ABV index (PP-ABV). A *probe* congruency index was first generated: fixation time on the face congruent with the probe (regardless of emotionality) was divided by the mean time of fixation on all probe-congruent faces. Thus, an above average fixation time on a probe-congruent face would be represented by a number higher than 1, and a below average fixation time would be a number between 0 and 1. The same procedure was adopted with the probe-incongruent face: fixation time on probe-incongruent face *divided by* mean fixation time on all probe-incongruent faces.

Then, an ABT index was generated by subtracting the probe-congruency index of the *threat face* from the probe-congruency index of the *neutral face*. A positive ABT index would indicate that a threat face had an increased fixation time relative to a neutral face – taking probe congruency into account. The sum of all in-trial ABT indices resulted in a general post-probe ABT index (PP-ABT) for each participant. Since the probe-congruency calculation already involves division by mean fixation times, no further correction for variance was conducted in order to calculate a post-probe ABV index (PP-ABV). Thus, the standard deviation of all in-trial ABT indices equals the novel variability index proposed in this study.

Reliability was investigated through the internal consistency of ABT indices and RTs (Cronbach's α) and through the split-halves method: trials in a task were randomly divided in two halves, which were then correlated. High correlation indices (e.g., higher than 0.7) indicate adequate internal consistency (Waechter et al., 2014). In the DPT, randomization was controlled so each half would have an equal number of neutral and threat trials and congruent and incongruent trials. Finally, a test-retest procedure was adopted. Indices at T1 and T2 were correlated, with higher correlation indices indicating acceptable consistency across sessions.

Data Treatment

A total of 44 trials (0.17% of all analyzed trials) were excluded from the final sample of the EST due to outlying RTs, i.e., outside the range of 200ms-2600ms. On the DPT, 52 trials (0.26%) were outside the range of 300ms-2400ms and were excluded. These ranges were determined upon analyzing outliers of our sample, as recommended by (Price et al., 2015). We also excluded from all eye tracking analyses the participants who had more than 24 trials (20%) of the DPT with no registered fixation time on either AOI after probe onset. This frequent lack of fixations after probe onset was interpreted as an indicator of an eye tracking detection problem. Exclusions are shown on Figure 6.

Results

Emotional Stroop Task

Psychometric characteristics

Internal consistency at T1 was high for general RTs (Cronbach's α = .96) and acceptable for the RT ABT index, i.e., the mean difference between threat and neutral RTs (α = .70), but not for the ABT index of response accuracy (α = .51). The correlation between halves composed of randomly selected trials at T1 was significant for total RTs ($r_P = .90$, $p < .01$), neutral RTs ($r_P = .90$, $p < .01$) and threat RTs ($r_P = .74$, $p < .01$). However, it was not significant for ABT indices of RT ($r_P = .02$, $p = .85$) and accuracy ($r_P = .20$, $p = .08$).

Test-retest correlations between T1 and T2 were significant for total RTs (r_P = .87, $p < .01$), including neutral RTs (r_P = .88, $p < .01$) and threat RTs (r_P = .78, $p < .01$), indicating acceptable reliability. However, once more no significant correlation was found between sessions on the ABT indices of RT (r_P = .06, p = .64) and accuracy (r_P = .06, p = .64). The ABV index had a significant correlation score between sessions, though unacceptably low (r_P < .38, $p < .01$). The ABT index was therefore unreliable between halves at T1 and between sessions (T1 and T2), tough it showed satisfactory internal consistency.

ABT and ABV

There were no significant differences (t = -1.81, p = .07) between RTs to threat words (M = 725.58, SD = 109.78) and RTs to neutral words (M = 735.12, SD = 108.32) at T1, what was against prior expectations. However, participants had a significantly *lower accuracy* (t = 7.93, $p < .01$) on *threat* words (M = .05, SD = .03) compared to neutral words (M = .02, SD = .02), what may indicate that an ABT impaired effective performance. Measures of ABT had no significant relationship with the ACS, neither on RTs (r_P = -.02, p = .86) nor accuracy (r_P = .18, p = .09). The same occurred with the PCL-5 (RTs: r_P = .01, p = .98; accuracy: r_P = .05, p = .64) and with the STAI-T (RTs: r_P = .01, p = .95; accuracy: r_P = .06, p = .57).

The index of ABV had a significant – though weak – positive correlation with the STAI-T (r_P = .22, p = .04), and no significant relationship with the ACS (r_P = .12, p = .28) or the PCL-5 (r_P = .13, p = .25). Interestingly, mean RTs in the EST (M = 727.92) were significantly slower (t = 2.14, p = .04) than RTs in the DPT (M = 706.06), probably due to the higher interference of an added response possibility (i.e., the additional third color).

Group differences

Participants with high (n = 35, *M* = 47.78, *SD* = 7.11) and low trait anxiety (n = 45, *M* = 31.27, *SD* = 3.83) were compared regarding ABT measures. No significant group effect was found on ABT indices of accuracy ($F = 1.18$, $p = .28$), on indices of RTs ($F = .04$, $p = .84$) or on the ABV index ($F = 1.70$, $p = .20$). The groups of high and low anxiety differed significantly on STAI-T scores ($t = 12.55$, $p < .01$).

In a subsample with trauma victims only (n = 50), those with high PTSS (n = 22, *M* = 19.45, *SD* = 11.19) were compared with those with low PTSS (n = 28, *M* = 4.18, *SD* = 2.64) on ABT indices. No group effect was found in the main interest measure of ABV ($F = .19$, $p = .66$) or in ABT measured through RTs ($F = .10$, $p = .75$) and accuracy ($F = 1.36$, $p = .25$). Groups differed significantly on PTSS scores ($t = 6.26$, $p = <01$). Thus, contrary to our expectations, there were no anxiety or PTSS group effects on the EST scores of ABT.

Dot-Probe Task

Psychometric characteristics

Reliability indices are presented on Table 4. *Pure* measures of both RT and gaze fixations were highly reliable throughout nearly all indices. Though accuracy measures were below acceptable reliability scores, they were relatively steady across reliability analyses. On the other hand, nearly all ABT indices resulted in unacceptable reliability scores, regardless of type of measurement. In fact, between-halves and test-retest analyses of RT-based ABT indices were significantly and *inversely* correlated, what indicates an important inconsistency across measurements.

Interestingly, the FV-ABV index had significant indications of reliability. This index represents the variability of in-trial facilitation indices during free visualization, and was more reliable that the facilitation index alone. The reliability scores of both novel PP-ABT and PP-ABV indices were overall unacceptable.

Table 4. *Reliability indices of the DPT*

	Internal consistency (α)	Split-halves (r_P)	Test-retest (r_P)
RTs	**.97**	**.93****	**.82****
threat trials	**.96**	**.86****	**.81****
control trials	**.91**	**.80****	**.82****
Accuracy (mean errors)	.58	.40**	.52**
threat trials	.55	.36**	.42**
control trials	.25	.15	.52**
RT ABT indices			
congruent – incongruent		.11	-.39*
incongruent – control		-.30**	.07
Accuracy ABT index		.09	.21
Eye tracking ABT indices			
all fixations	**.96**	**.92****	.66**
FV fixations	**.91**	**.93****	**.74****
PP fixations	**.95**	**.92****	**.73****
facilitation index	.09	.12	.19
disengagement index	†	.13	-.10
avoidance index	†	.11	.45**
PP ABT index	.29	-.09	.30
FV-ABV index		**.86****	.61**
PP-ABV index		.02	.16

Note: acceptable reliability indices (>.07) are in bold. Lower indices (including negative values) are indicative of poorer reliability. For RT and accuracy measures, n = 85 (n = 63 for test-retest). For eye tracking measures, n = 64 (n = 40 for test-retest); *p* values were not calculated for α scores; α= Cronbach's α; r_P = Pearson's *r*; RT= Reaction Times; ABT= Attentional bias relative to threat; FV= Free visualization period; PP= Post probe onset period; ABV= Attentional bias variability.
†= not enough trials to calculate; $^{*}p < .05$; $^{**}p < .01$.

Total fixation time in milliseconds was overall significantly higher in stimuli positioned to the *left* of the screen than to the right, what was observed even prior to probe onset in control trials (M_{left} = 247.25, SD_{left} = 74.93, M_{right} = 107.11, SD_{right} = 55.27, t = 10.39, $p < .01$). This left vs. right unbalance appears not to have been reflected on keypress responses, since there were no significant differences (t = -1.47, p = .15) between RTs on trials with probes on the left (M = 693.40, SD = 123.78) and trials with probes on the right (M = 703.18, SD = 125.56).

Furthermore, an unexpected time measurement variation was observed in portions of the task that had predefined durations. For example, the free visualization period was set to 800ms. Of all occurrences (n = 12,360, *M* = 805.44, *SD* = 15.84, range: 733-933), measurements of 800ms represented only 31.6%, while 799ms measurements occurred 33.6% of times (totaling 65.2% occurrences between 799ms and 800ms). Several occurrences were ~33ms after (20.6% between 832ms and 834ms) or ~33ms prior (3.3% between 765ms and 767ms) to the pre-established 800ms, what indicates a relatively steady sampling error rate of 33ms in data collection. This is likely attributable to the utilized software and extendable to all trial durations and measurements in this study.

Convergent validity

Correlation indices between eye tracking and RT measures of ABT are shown on Table 5. Interestingly, the fixation time index of *disengagement* shared a moderate direct correlation with the classical RT measure of disengagement (Koster et al., 2004), what indicates a significant level of convergent validity between these measures. Our proposed facilitation and avoidance indices, however, did not relate with any classical measure of ABT. The classical measure of vigilance-avoidance (i.e., RT congruent – RT incongruent) did not significantly relate with the novel eye tracking-based PP-ABT measure, though this (inverse) relationship approached statistical significance ($r_P = -.23$, $p = .07$). The PP-ABT measure had a weak direct relationship with the RT-based disengagement measure.

Furthermore, the PP-ABT index had a weak positive correlation with the *gaze fixation* index of disengagement ($r_P = .42$, $p < .01$) and an inverse moderate correlation with the fixation index of avoidance ($r_P = -.62$, $p < .01$), what was according to expected and is an important indication of internal validity of these indices. This latter inverse relationship, for example, is likely due to the fact that a positive PP-ABT index reflects higher relative fixation durations on threat faces, the same that is interpreted from a *negative* avoidance index. There was no significant relationship ($r_P = .20$, $p = .11$) between ABV indices (i.e., FV-ABV and PP-ABV).

Table 5. *Correlations between classical and eye tracking ABT measures*

	RT congruent – RT incongruent	RT incongruent – RT neutral	Accuracy index
facilitation index	-.12	-.05	-.14
disengagement index	-.38**	.64**	.11
avoidance index	.06	-.09	-.05
PP-ABT index	-.23	.31*	.16
FV-ABV index	.01	-.13	.02
PP-ABV index	.21	-.09	-.02

Note: For all measures, n = 64; all indices are Pearson *r* correlation indices (r_P); RT= Reaction Times; ABT= Attentional bias relative to threat; PP= Post probe onset period; FV= Free visualization period; ABV= Attentional bias variability.
$^{*}p < .05$; $^{**}p < .01$.

ABT and ABV

Differences between threat and neutral indices across the whole sample at T1 are summarized on Table 6. There were no significant differences at T1 between mean RT and accuracy measures on threat and neutral trials – i.e., no effect of threat on RTs and error rate. However, eye tracking measures revealed an increased fixation time *post* probe onset on threat faces when compared to all neutral faces and to neutral faces in control trials. Similarly, a marginally significant difference occurred in the *free visualization* period between neutral faces in control trials ($p = .05$). Thus, eye tracking measurement was more sensitive to a bias towards threatening faces than measures of RTs and of accuracy. As expected, a significant attentional bias towards probe-congruent stimuli was identified.

Table 6. *Comparisons between threat vs. neutral and congruency measures*

	M (*SD*)	*t* score (*p* value)
RTs in threat trials	705.55 (131.42)	
RTs in control trials	700.56 (124.14)	1.29 (.20)
RTs in threat-congruent trials	708.41 (136.88)	
RTs in threat-incongruent trials	702.69 (136.03)	.72 (.47)
RTs in control trials	700.56 (124.14)	1.29 (.20)
Mean errors in threat trials	.02 (.02)	
Mean errors in control trials	.02 (.03)	.91 (.37)
Mean errors in threat-congruent trials	.02 (.03)	
Mean errors in threat-incongruent trials	.02 (.03)	-.56 (.58)
Mean errors in control trials	.02 (.03)	.50 (.62)
FV fixation on threat	182.85 (40.83)	
FV fixation on neutral (threat trials)	177.56 (44.92)	1.14 (.26)
FV fixation on neutral (control trials)	177.19 (37.15)	1.99 (.05)
FV fixation on neutral (all)	177.38 (39.06)	1.57 (.12)
PP fixation on threat	240.90 (66.86)	
PP fixation on neutral (threat trials)	235.74 (59.44)	1.39 (.17)
PP fixation on neutral (control trials)	233.94 (60.31)	2.44 (.02)*
PP fixation on neutral (all)	234.84 (58.39)	2.11 (.04) *
Fixation on probe-congruent	364.17 (106.11)	
Fixation on probe-incongruent	108.47 (65.55)	16.20 (<.01)**

Note: For RT and accuracy measures, n = 85. For eye tracking measures, n = 64; all temporal measures are in milliseconds (ms); RT= Reaction Times; *M*= Mean; *SD*= Standard Deviation; FV= Free visualization period; PP= Post-probe onset period.
**p* < .05; ** *p* < .01.

Relationships of ABT indices with the ACS, PCL-5 and STAI-T symptom scales are presented on Table 7. Neither scale had a significant relationship with ABT indices based on RT measures and accuracy. Interesting significant – though weak – correlations emerged from *eye tracking* measures of ABT: the ACS related more significantly with the novel *post* probe onset ABT measure (i.e., less time on threat faces relative to neutral), which is measured on a period that is indeed expected to involve more volitional AC. Meanwhile, measures of early orientation to threat in the *free visualization* period were more significantly related with posttraumatic symptoms. This is in line with previous hypotheses. However, contrary to expectations, the FV-

ABV index was *inversely* correlated with the PCL-5. This indicates that the *stability* of an early ABT *increased* when clinical scores of PTSS were higher.

Table 7. *Correlations between ABT scores and clinical scales*

	ACS	PCL-5	STAI-T
RT ABT indices			
congruent – incongruent	-.03	.05	.09
incongruent – control	.03	.14	-.06
Accuracy ABT index	.01	.05	.09
Eye tracking ABT indices			
facilitation index	-.07	$.31^{*}$	.01
disengagement index	-.14	.10	-.18
avoidance index	$.27^{*}$	.14	.06
PP-ABT index	$-.47^{**}$	-.14	-.22
FV-ABV index	-.24	$-.36^{**}$	-.21
PP-ABV index	-.03	-.02	-.02

Note: For RT and accuracy measures, n = 85. For eye tracking measures, n = 64; all indices are Pearson's *r*; RT= Reaction Times; ABT= Attentional bias relative to threat; PP= Post probe onset period; FV= Free visualization period; ABV= Attentional bias variability.
$^{*}p < .05$; $^{**}p < .01$.

Group differences

Two ANCOVAs were conducted to test for group effects of high (n = 32, *M* = 48.06, *SD* = 6.87) vs. low (n = 29, *M* = 31.66, *SD* = 3.69) *trait anxiety* and high (n = 19, *M* = 20.79, *SD* = 11.50) vs. low (n = 21, *M* = 4.05, *SD* = 2.40) *posttraumatic symptoms* on all ABT measures, controlling for ACS scores (set as a covariable). Results are summarized on Table 8. Highly anxious participants had higher mean RT vigilance-avoidance indices than their less anxious counterparts. The high-anxious group was also more stable in this ABT towards threat with low ABV scores relative to the low-anxiety group. The high-PTSS group had a stronger trend of fixating on threat faces on the free visualization period than the low-PTSS group. The remaining ABT and ABV indices suffered no significant group effects.

Table 8. *ANCOVAs for ABT scores in high vs. low anxiety and PTSS*

		STAI-T			PCL-5		
		M	$F_{(1,59)}$	p (η^2)	*M*	$F_{(1,38)}$	p (η^2)
RT ABT indices							
congruent-incongruent	high	18.99	**5.41**	**.02 (.06)**	7.97	.97	.76 (.00)
	low	-10.16			4.48		
incongruent-control	high	-6.51	3.23	.07 (.04)	16.60	.51	.48 (.01)
	low	11.76			2.68		
Accuracy ABT index	high	.002	.13	.72 (.00)	.003	.34	.56 (.01)
	low	.003			.006		
Eye tracking ABT indices							
facilitation index	high	5.79	.92	.34 (.01)	16.45	**6.94**	**.01 (.16)**
	low	3.52			-12.74		
disengagement index	high	-9.42	1.06	.31 (.01)	1.32	.33	.57 (.01)
	low	.11			-2.92		
avoidance index	high	-7.88	.32	.57 (.00)	-8.96	.02	.88 (.00)
	low	-10.14			-13.75		
PP-ABT index	high	-1.87	2.03	.16 (.02)	.04	.01	.92 (.00)
	low	-4.59			4.70		
FV-ABV index	high	1.02	**4.49**	**.04 (.05)**	1.76	3.16	.08 (.08)
	low	1.71			2.11		
PP-ABV index	high	1.94	3.44	.07 (.04)	1.71	.18	.64 (.01)
	low	3.62			1.75		

Note: in STAI-T analysis, n= 61; in PCL-5 analysis, n= 40; indices with $p < .05$ are in bold; *M*= mean; η^2= partial eta squared; RT= Reaction Times; ABT= Attentional bias relative to threat; PP= Post probe onset period; FV= Free visualization period; ABV= Attentional bias variability.

Discussion

Reliability

Our findings corroborate those of previous investigations, i.e., an excellent reliability of *pure* measures (RT and gaze fixation times), combined with unacceptable reliability of ABT indices, regardless of type of measure of the EST and the DPT (Ataya et al., 2012; Brown et al., 2014; Chapman, Devue, & Grimshaw, 2017; Dear et al., 2011; Eide et al., 2002; Kappenman et al., 2014; Price et al., 2015; Schmukle, 2005; Staugaard, 2009; Strauss et al., 2005; Waechter et al., 2014).

In fact, these studies were all publications we found which analyzed the reliability of the EST and adapted DPT, and all – but one – reported *unacceptable* reliability of ABT measures and acceptable reliability of *pure RT* measures. The exception is the very recent study by Chapman et al. (2017) with the DPT, which reported poor acceptable reliability of ABT measures in short stimuli presentations (i.e., 100ms), but still unacceptable reliability in longer durations (i.e., 300ms, 500ms and 900ms). Price et al. (2015) published important recommendations to improve reliability of ABT measures in DPT, and even found a higher reliability index in ABV scores. However, they conclude that "when applying these strategies to RT data across three distinct studies, reliability of bias scores tended to improve, but remained below levels typically recommended for psychometric adequacy" (p. 374).

If such findings are indeed stable, this would mean that such tasks reliably measure only participants' tendency to maintain RTs across trials, which is a very unimpressive standard. In this study, the same results were replicated. The important reviews by Cisler and Koster (2010) and Bar-Haim et al. (2007) do not focus on reliability assessments. This is a serious problem, already recognized on the field of ABT for more than a decade (e.g., Eide et al., 2002; Schmukle, 2005), and requires addressing in future review studies.

ABT and ABV measures

The reported lack of reliability may be related to findings regarding validity of the indices proposed in this study. Still, the EST and DPT have been used in hundreds of studies which reported significantly higher ABT in anxious individuals (Bar-Haim et al., 2007). The ABT index of the EST did not provide any indication of a relationship with anxiety or other processes that might influence ABT (e.g., poor AC) in this study. The only indication of an ABT was the accuracy index, with a higher error rate on threat words. According to Eysenck's Attentional Control Theory (Eysenck & Derakshan, 2011), an impaired efficiency (i.e., higher RTs) would appear to more extent than an impaired effectiveness (i.e., lower accuracy) in anxious individuals, though this did not occur on the EST in this study.

On the DPT, however, the *facilitation* index was significantly higher in the high-PTSS traumatized sample, and a trend to differentiate orientation to threat from orientation to neutral stimuli occurred with fixations on the free visualization period, though not with RT measures, which is surprising. On the other hand, the facilitation-based FV-ABV index presented relationships contrary to what was expected – indicating more *stable* measures of ABT in the high-anxious group and on higher PCL-5 scores. Though this index showed signs of acceptable reliability, its validity needs to be further addressed.

An important finding about the *disengagement* index regarded its convergent validity. The relationships of this index with classical RT indices thought to reflect a delay in disengaging from threat (especially the *incongruent – control* calculation) are good indications of validity. However, this eye tracking-based index did not relate to any clinical measure or group and must therefore be subject to further investigations. The *avoidance* bias was the one specific bias to show any sign of a test-retest reliability. Furthermore, it related to the PP-ABV index and to higher AC difficulties (as measured by the ACS). We expected an inverse relationship of the eye tracking-based *avoidance* index with the classical RT ABT measure of vigilance-avoidance, though this did not occur. Instead, marginal statistical significance occurred on the relationship between the PP-ABT and the vigilance-avoidance index.

In fact, the RT vigilance-avoidance index had a good indication of validity: it was subject to a group effect of high trait-anxiety. Other than that, RT indices of ABT were highly unreliable and had very low validity in this study. We expected to find a difference between RTs to threat and control trials, though this did not occur.

Findings regarding the novel ABV indices proposed in this study were not according to what was expected. However, our sample is not a clinical sample of individuals with PTSD. In fact, the general level of PTSS symptoms was not high (M = 9.66, SD = 9.68), especially when compared to other studies identifying significant ABV scores in experimental groups (Badura-Brack et al., 2015; Iacoviello et al., 2014; Naim et al., 2015). We believe that the generation of in-trial ABT indices (e.g., PP-ABT) is likely to contribute to identifying heightened ABV in such samples.

We found a significant mean RT delay in the EST compared to the DPT. This is contrary to our initial expectations, since the DPT requires overt orienting to the target stimulus (i.e., to the left or to the right) and is likely to induce a more intense threat-processing due to the nature of its stimuli (Pishyar, Harris, & Menzies, 2004). This delay is likely due to the increase in cognitive processing demands generated by the addition of a third response possibility (i.e., the color red). Participants often mentioned that the EST was "harder" than the DPT. This indicates that, though the EST and the original Stroop task are indeed different regarding their underlying mechanisms, resolving conflict between response possibilities has a strong influence on RTs, even when compared to the inhibition of threat processing. As Cisler and Koster (2010), we recommend the investigation of the effect of increasing cognitive load on experimental tasks of ABT, which is likely to affect AC mechanisms – and disengagement and avoidance processes. This could be achieved by increasing response possibilities (e.g., adding another color on the adapted DPT).

Limitations

One possible limitation of the present study were the trial durations in the DPT. Due to practical restraints, this study only included one option of free visualization time (i.e., 800ms of asynchrony with target onset). This may be too long a duration, since even *avoidance* bias, thought to be a bias with later onset than facilitation and disengagement, was identified as early as 500ms (Cisler, Bacon, & Williams, 2009). In future studies, similar adaptations of the DPT should add and compare different trial durations (e.g., 150ms and 500ms) preceding the target stimulus. Our choice of measuring *total gaze fixation time* in pictorial stimuli to calculate ABT has been previously reported to be as reliable as any (Price et al., 2015) – however, alternatives exist (e.g., first fixation duration, number of fixations, pupil diameter). In fact, total fixation on threat faces during free visualization may not be the best measure of an *initial* orientation to threat (e.g., as first fixation duration). This should be better explored in future studies with adapted DPTs.

Another possible limitation was the intensity and salience of the threat stimuli. Though faces and words selected for the study were those with most extreme valence and arousal scores, participants often stated that very few faces in the DPT would actually be considered *threatening*. Furthermore, we observed that threat words in the EST impacted RTs more when they were on first position inside the trial. Since positions were randomized in every presentation, this was not controlled. A higher letter case size is also recommended, what may enhance salience of written content. We did not alter images in the DPT, e.g., removing hair, ears, neck and shoulders from the image (as in Price et al., 2015), what would likely increase salience of emotional content. Intensity of the threat-related stimuli is crucial for threat paradigms (Cisler & Koster, 2010).

Furthermore, the ethnically-homogeneous sample of White participants was unmatched with the equal distribution of gender and ethnicity across pictures of the DPT, what may have influenced threat assessment. The problem of homogeneous samples in experimental studies with university students is precedented (Henrich, Heine, & Norenzayan, 2010). Several studies report biases of attentional engagement of participants with ethnicities different than those of the models of pictorial stimuli (Avenanti, Sirigu, & Aglioti, 2010; Correll et al., 2007; Hills & Lewis, 2006; Sheng, Liu, Zhou, Zhou, & Han, 2013). We hypothesize that, at least in the Brazilian context, stereotypical racial and gender representations may have influenced threat assessment. We recommend that future research investigates perceived intensity of threat stimuli, as well as the relationship between ABT and the ethnicity and gender of participants and models.

Limitations in our experimental setting and apparatus require consideration. Data extracted from the Ogama software presented noticeable 33ms sampling error rates in time measurements (a standard deviation of 15.84) – including in RTs. This variation was not controlled for during calculation of indices and its reasons were also not accounted for. Most importantly, the choice to present stimuli bilaterally (instead of vertically) is discouraged. This may be prevented by the use of eye-trackers with no reports of detection problems in lower portions of presentation monitors. Such trackers are also significantly more expensive, what needs to be considered when planning research on ABT.

We did not find a preferential explanation to the difference in fixation time between stimuli positioned on the *left vs. right* side of the screen on the DPT. Possible explanations include hemispherical neurological differences in emotional and threat processing (e.g., Liberzon & Abelson, 2016), though this difference in fixation time was observed in neutral-neutral trials. Other possible explanations for this unbalance are the presence of the researcher on the left side of the participant during the task, automatic tendencies of orienting to the left of computer screens (e.g., due to language-specific reading patterns) and a technical problem of the tracker, though this was not verified.

In any case, this unbalance surely influenced all other indices relying on eye tracking measurements in this study, especially the *facilitation* index, which relied on in-trial differences between faces on each side. However, eye tracking measurements were overall highly reliable and all target, threat and neutral stimuli were side-balanced, with equal frequencies of occurrence on each side. To avoid such problems in the future, we recommend the *vertical presentation* of stimuli and a lower angle of images relative to the eyes of participants (i.e., setting stimuli *closer* to one another, as in Price et al., 2015). This may lessen the impact of a possible automatic tendency to direct one's gaze to any given part of the screen.

Strengths

An important strength of this study is the development of adapted tasks highly oriented by theoretical foundations of attention, with a task design and data analysis plan that allow for the differentiation of known attentional biases and comparisons of eye tracking and classical RT indices of ABT. Especially, we believe that the proposition of the *probe-congruency index* is novel, which may be of great importance to research with DPT paradigms utilizing eye tracking technology. The ability to calculate an *in-trial* ABT index may preclude the necessity of inter-trial calculations (e.g., threat congruent – threat incongruent) to investigate classical ABT hypotheses in the future. Furthermore, our data treatment observed very strict standards, and our sample size was large enough to sustain this rigorous treatment. Though low reliability was found for ABT measures, pure measures of RT and eye tracking were highly reliable. It is worth mentioning that the eye tracking measurement was at least very sensitive to probe congruency. This may be an obvious finding, but it is also a strong indicator of validity of the measure.

An important proposition in this study is the clear differentiation of biases with eye tracking measures. For example, *disengagement* was not calculated only as a mean of incongruent *minus* neutral times across all trials, but through aggregate scores of a more specific in-trial index (e.g., fixation time on threat *on the left* with circle on the right *minus* mean fixation time *on the left* in neutral-neutral trials with probe on the right). This is hypothesized to be an improvement in comparison with the most utilized strategies of ABT operationalization (e.g., Koster et al., 2004). Furthermore, the calculation of ABV across *all trials*, instead of dividing trials across blocks (e.g., Iacoviello et al., 2014), is likely to be a more statistically reliable way of measuring variability.

The utilization of a colored target ellipse *without* the withdrawal of pictorial stimuli on the DPT was considered a promising proposal, to be further investigated. As opposed to traditional practice in DPT research, this may strengthen the eye tracking analyses of ABT, especially if certain recommendations listed in this study are followed (e.g., editing pictures as in Price et al., 2015). Furthermore, the inclusion of an initial period of free visualization *vs.* an AC demanding period of probe classification may be of use to researchers aiming to differentiate types of ABT with eye tracking technology.

We were able to identify important attentional repercussions of task design. For example, the division of the EST in 4-word trials revealed that words on the first position of a trial were more likely to induce a more intense *orienting response* – interpreted by the heightened RTs for first positions across the entire sample. Future studies may analyze the differential effect that positioning may have on ABT and the orienting response, for example, by comparing RTs between (a) first position threat words *vs.* first position neutral words and (b) threat words vs. neutral words on the following positions. This strategy may be useful in isolating the effect of the orientation response from the activation of threat-related semantic content.

Conclusion

Adaptations such as the ones proposed in this study are required in order to integrate empirical findings and models of ABT with comprehensive theoretical models of attention and current operationalization strategies (e.g., eye tracking). Though indices of ABT in this study were overall unreliable and showed questionable validity, this is also reported in previous studies assessing psychometric characteristics of the DPT and, especially, the EST. Gaze fixation measures were superior to classical RT measures in detecting a general bias towards threatening faces in the DPT. The novel in-trial ABT and ABV indices are expected to be an improvement regarding the operationalization of different types of bias, compared to RT-based indices which are traditionally calculated between trials or between trial blocks.

As stated by Price et al. (2015), “reliability sets a theoretical upper limit on the task’s validity (i.e., its ability to covary with and/or predict other outcomes)” (p. 366). The lack of reliability *and* of several indices of validity identified in both tasks in this study may indicate that a limit was breached: the limit set by widely reported – but not yet systematically reviewed – reliability problems on these tasks which preclude complexification of task designs and of analysis strategies. Development of novel integrative tasks may be challenging, and our results may indicate that design specifications were still not optimal. However, we believe that alternate designs and analyses such as those proposed in this study may be at the future of ABT research.

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PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Vieses e o Controle da Atenção no Transtorno de Estresse Pós-Traumático: uma análise integrativa de tipos de processamento e métodos de mensuração

Pesquisador: Christian Haag Kristensen

Área Temática:

Versão: 2

CAAE: 66491417.1.0000.5336

Instituição Proponente: UNIAO BRASILEIRA DE EDUCACAO E ASSISTENCIA

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.064.079

Apresentação do Projeto:

O Transtorno de Estresse Pós-Traumático (TEPT) tem entre seus principais marcadores diagnósticos a presença de sintomas intrusivos e a vigilância acentuada para estímulos ameaçadores, o que pode ser entendido a partir de uma desregulação do sistema que detecta e orienta o organismo para ameaças. Através de três estudos, pretende-se esclarecer o papel de diferentes aspectos do processamento atencional na orientação para ameaça de indivíduos com TEPT. Nos Estudos I e II, serão validadas tarefas experimentais computadorizadas para avaliação de viés e controle atencional do TEPT (i.e., tarefa de Stroop emocional [ameaça] e tarefa Dot-Probe com faces de ameaça e rastreamento ocular). Serão convocados 100 participantes universitários para ambos os estudos iniciais. No Estudo III, as tarefas supracitadas serão utilizadas conjuntamente com medidas de autorrelato e tarefas neuropsicológicas clínicas de avaliação de controle atencional (e.g., Teste Hayling, Teste de Trilhas, Teste dos Cinco Dígitos), porém, com população clínica de indivíduos vítimas de trauma (n=80), com e sem diagnóstico de TEPT.

Objetivo da Pesquisa:

Investigar como diferentes aspectos do processamento atencional medidos com diferentes paradigmas relacionam-se com o TEPT e com sintomas pós-traumáticos.

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Bairro: Partenon **CEP:** 90.619-900
UF: RS **Município:** PORTO ALEGRE
Telefone: (51)3320-3345 **Fax:** (51)3320-3345 **E-mail:** cep@pucrs.br

Avaliação dos Riscos e Benefícios:

Riscos: Riscos ao bem estar dos participantes limitam-se ao contato com memórias traumáticas ou aversivas durante a avaliação por meio dos instrumentos clínicos. Esse risco será informado previamente aos participantes, e será disponibilizado auxílio a quaisquer participantes que demandarem, caso relatem sofrimento ligado ao acesso a tais memórias durante a pesquisa.

Benefícios: Os benefícios aos participantes limitam-se ao retorno que poderão obter, caso seja de interesse dos mesmos, sobre a avaliação clínica e as tarefas experimentais realizadas. A devolução da avaliação clínica e neuropsicológica é padrão para toda a população clínica do NEPTE.

Comentários e Considerações sobre a Pesquisa:

A pesquisa é relevante e propõe métodos adequados para o alcance de seus objetivos.

Considerações sobre os Termos de apresentação obrigatória:

Todos os termos necessários são apresentados e as alterações solicitadas pelo Comitê de Ética em Pesquisa foram realizadas.

Conclusões ou Pendências e Lista de Inadequações:

Diante do exposto, o CEP-PUCRS, de acordo com suas atribuições definidas nas Resoluções n° 466 de 2012, n° 510 de 2016 e da Norma Operacional n° 001 de 2013 do Conselho Nacional de Saúde, manifesta-se pela aprovação do projeto de pesquisa proposto.

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_INFORMAÇÕES_BÁSICAS_DO_PROJETO_859062.pdf	08/05/2017 15:51:07		Aceito
Outros	cartaRespostaPendencias.doc	08/05/2017 15:40:20	Christian Haag Kristensen	Aceito
Projeto Detalhado / Brochura Investigador	Projetao_Vies_e_Controle_para_SIPESQ_pos_alteracoes.docx	19/04/2017 16:58:30	Christian Haag Kristensen	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_alterado_para_SIPESQ_pos_parecer.pdf	19/04/2017 16:56:12	Christian Haag Kristensen	Aceito
Outros	CartaApresentacaoEquipe2.pdf	29/03/2017 15:23:46	Christian Haag Kristensen	Aceito
Outros	CartaCepApresentacao.pdf	27/03/2017	Christian Haag	Aceito

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Outros	CartaCepApresentacao.pdf	14:54:36	Kristensen	Aceito
Outros	CEP_Carta_autorizacao_chefe_do_servico.pdf	14/03/2017 16:53:43	Christian Haag Kristensen	Aceito
Outros	Documento_Unificado_do_Projeto_de_Pesquisa_1485456961745.pdf	14/03/2017 16:47:25	Christian Haag Kristensen	Aceito
Folha de Rosto	Folha_de_rosto_assinada.pdf	07/02/2017 17:16:03	Christian Haag Kristensen	Aceito
Orçamento	orcamento_assinado_para_SIPESQ.pdf	30/01/2017 03:25:17	Christian Haag Kristensen	Aceito
Cronograma	cronograma_atualizado.docx	30/01/2017 03:23:04	Christian Haag Kristensen	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

PORTO ALEGRE, 15 de Maio de 2017

Assinado por:
Denise Cantarelli Machado
(Coordenador)

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Anexo B – TCLE

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Sou membro do Grupo de Pesquisa Cognição, Emoção e Comportamento do Programa de Pós-graduação em Psicologia da Pontifícia Universidade Católica do Rio Grande do Sul (PPGP-PUCRS), e estou realizando uma pesquisa chamada "Vieses e o controle da atenção no Transtorno de Estresse Pós-Traumático: uma análise integrativa de tipos de processamento e métodos de mensuração" sob a orientação do Prof. Dr. Christian Haag Kristensen do PPGP-PUCRS. Essa pesquisa pretende verificar aspectos da atenção de indivíduos que passaram por situações traumáticas, para melhor compreender os processos envolvidos na orientação para estímulos ameaçadores e não ameaçadores. Acreditamos que isso é importante porque poderá ajudar no entendimento de aspectos atencionais que influenciam o desenvolvimento e a severidade de sintomas do Transtorno de Estresse Pós-Traumático (TEPT).

Você está sendo convidado(a) a participar voluntariamente de uma etapa inicial dessa pesquisa, com objetivo de validar tarefas experimentais que avaliam a orientação atencional para estímulos ameaçadores. Se você consentir em participar, responderá a questionários investigando diversos aspectos de sua vida, inclusive questões que podem ter lhe provocado sofrimento. A seguir, realizará tarefas computadorizadas que exigirão o uso de sua atenção, envolvendo visualizar imagens e palavras. Algumas dessas imagens (fotos de expressões faciais) e palavras foram avaliadas por outras pessoas como ameaçadoras, outras não. Pediremos que você compareça duas vezes (com intervalo de uma semana) ao local de realização da pesquisa no PPGP-PUCRS, para realização de um total de dois encontros com duração estimada de uma hora cada.

Possíveis desconfortos e riscos a você incluem relembrar aspectos de sua vida que podem lhe causar sofrimento psicológico. Além disso, você pode entrar em contato com palavras e imagens de conteúdo ameaçador. Também, você deverá dispor de uma parcela do seu tempo para a pesquisa. Você tem o direito de solicitar uma indenização por qualquer dano que resulte da sua participação neste estudo. Em caso de algum problema relacionado com a pesquisa, você terá direito a assistência gratuita, que será prestada pelos pesquisadores responsáveis em horário e local a serem combinados com você.

Os benefícios diretos desta pesquisa para você são restritos, e se limitam ao retorno verbal que você poderá ter sobre os dados levantados. Indiretamente, você estará promovendo o avanço do conhecimento científico. A participação neste estudo é voluntária e, se você decidir não participar ou quiser desistir de continuar em qualquer momento, tem absoluta liberdade de fazê-lo, sem qualquer prejuízo ou retaliação. Na publicação dos resultados dessa pesquisa, sua identidade será mantida no mais rigoroso sigilo. Serão omitidas todas as informações que permitam identifica-lo(a), as quais só estarão ao acesso dos pesquisadores responsáveis.

Qualquer desconforto causado, ou dúvidas relativas a esta pesquisa poderão ser discutidos a qualquer momento com o pesquisador responsável, Christian Haag Kristensen, pelo fone do NEPTE, (51) 3353-4898. Caso você tenha qualquer dúvida quanto aos seus direitos como participante de pesquisa, entre em contato com Comitê de Ética em Pesquisa da Pontifícia Universidade Católica do Rio Grande do Sul (CEP-PUCRS), em (51) 33203345, Av. Ipiranga, 6681/prédio 50 sala 703, CEP: 90619-900, Bairro Partenon, Porto Alegre – RS, e-mail: cep@pucrs.br, de segunda a sexta-feira das 8h às 12h e das 13h30 às 17h.O Comitê de Ética é um órgão independente constituído de profissionais das diferentes áreas do conhecimento e membros da comunidade. Sua responsabilidade é garantir a proteção dos direitos, a segurança e o bem-estar dos participantes por meio da revisão e da aprovação do estudo, entre outras ações.

Ao assinar este termo de consentimento, você não abre mão de nenhum direito legal que teria de outra forma.Não assine este termo de consentimento a menos que tenha tido a oportunidade de fazer perguntas e tenha recebido respostas satisfatórias para todas as suas dúvidas.Se você concordar em participar deste estudo, você rubricará todas as páginas e assinará e datará duas vias originais deste termo de consentimento. Você receberá uma das vias para seus registros e a outra será arquivada pelo responsável pelo estudo.

CONSENTIMENTO DO(A) PARTICIPANTE

Eu, ___________________________________, após a leitura deste documento e de ter tido a oportunidade de conversar com o pesquisador responsável, para esclarecer todas as minhas dúvidas, acredito estar suficientemente informado(a), ficando claro para mim que minha participação é voluntária e que posso retirar este consentimento a qualquer momento sem penalidades ou perda de qualquer benefício. Estou ciente também dos objetivos da pesquisa, dos procedimentos aos quais serei submetido, dos possíveis danos ou riscos deles provenientes e da garantia de confidencialidade e esclarecimentos sempre que desejar.

Diante do exposto, expresso minha concordância de espontânea vontade em participar deste estudo.

____

Assinatura do(a) participante

DECLARAÇÃO DO(A) PROFISSIONAL QUE OBTEVE O CONSENTIMENTO

Expliquei integralmente este estudo ao(à) participante. Na minha opinião e na opinião do(a) participante, houve acesso suficiente às informações, incluindo riscos e benefícios, para que uma decisão consciente seja tomada.

_______________________________________ _______________________________

Nome e assinatura do pesquisador Local e data

Matrícula:

Anexo C – Ficha de dados sociodemográficos

FICHA DE DADOS PESSOAIS ESOCIODEMOGRÁFICOS - ID _______

Nome Completo: ____ Data:___/___/____
Telefone para contato:(__) ______ - ______ E-mail: _______________________________
Endereço: ____
Sexo:1.( ) Feminino / 2.( ) Masculino
Data de Nascimento:_____/_____/_______ Idade:____ anos ____ meses
Local de Nascimento:___________________________ UF:____
Lateralidade: 1. ( ) Canhoto / 2. ( )Destro / 3. ( ) Ambidestro
Etnia ou raça: 1. ( )Asiática/2. ( )Branca/ 3.( )Indígena/ 4. ( )Negra/ 5. ( )Parda /
6. ( ) Outra: ________________ / 7. ( ) Prefiro não responder

Faz uso de alguma medicação atualmente? 1. ( ) Sim / 2. ( ) Não
Qual: ____
Dose: ____

Alguma dessas medicações foi utilizada nas últimas 24 horas? 1. ( ) Sim / 2. ( ) Não
Qual: ____

Fez uso de alguma medicação no passado? 1. ( ) Sim / 2. ( ) Não
Qual:____
Dose:____

Faz uso de alguma droga (incluindo álcool e tabaco) atualmente? 1. ( ) Sim / 2. ( ) Não
Qual:____
Quantidade:____

Alguma dessas drogas foi utilizada nas últimas 12 horas? 1. ( ) Sim / 2. ( ) Não
Qual: ____

Fez uso de alguma droga (incluindo álcool e tabaco) no passado? 1. ( ) Sim / 2. ( ) Não
Qual:____
Quantidade: ____

Você já teve algum tipo de doença, acidente ou infecção neurológica ou cardíaca ou problema de visão? (p. ex., traumatismo cranioencefálico, meningite, sífilis, hipertensão, miopia, astigmatismo)1. ( ) Sim / 2. ( ) Não
Qual: ____

Você já foi diagnosticado com algum transtorno psiquiátrico? 1. ( ) Sim / 2. ( ) Não
Qual: ____

Quantas horas você dormiu de ontem para hoje?________________
Você considera que teve uma noite de sono normal/adequada?1.( ) Sim / 2. ( ) Não

Você ingeriu café/cafeínaou nicotina (cigarro) nas últimas 3 horas?1.( ) Sim / 2. ( ) Não

Por quantos anos você estudou em escola e faculdade ou fez algum curso (ensino formal/acadêmico, sem contar repetências)?
Quantidade: ______________________

Agora, vou lhe fazer algumas perguntas a respeito dos seus hábitos de leitura e de escrita.

Hábitos de leitura (“Com que freqüência você lê...”)	jornal	(4) todos os dias	(3) alguns dias por semana	(2) 1 vez por semana	(1) raramente	(0) nunca
	notícias (online)	(4) todos os dias	(3) alguns dias por semana	(2) 1 vez por semana	(1) raramente	(0) nunca
	livros	(4) todos os dias	(3) alguns dias por semana	(2) 1 vez por semana	(1) raramente	(0) nunca
	outros	(4) todos os dias	(3) alguns dias por semana	(2) 1 vez por semana	(1) raramente	(0) nunca
	quais outros?					**Total:___/16**
Hábitos de escrita (“Com que freqüência você escreve...”)	textos formais	(4) todos os dias	(3) alguns dias por semana	(2) 1 vez por semana	(1) raramente	(0) nunca
	recados informais / postagens	(4) todos os dias	(3) alguns dias por semana	(2) 1 vez por semana	(1) raramente	(0) nunca
	outros	(4) todos os dias	(3) alguns dias por semana	(2) 1 vez por semana	(1) raramente	(0) nunca
	quais outros?					**Total:___/12**

Nível de Instrução:		**Estado Civil:**		**Situação Ocupacional:**	
( ) 1	Ens. Fund. Incompl.	( ) 1	Solteiro(a)	( ) 1	Emprego c/ cart. Assinada
( ) 2	Ens. Fund. Completo	( ) 2	Casado(a)	( ) 2	Emprego Sem Cart. Ass.
( ) 3	Ens. Médio Incompl.	( ) 3	Separado(a)	( ) 3	Profissional Liberal
( ) 4	Ens.MédioCompleto	( ) 4	Divorciado(a)	( ) 4	Autônomo
( ) 5	Ens. Super. Incompl.	( ) 5	Viúvo(a)	( ) 5	Sem atividade remunerada
( ) 6	Ens. Super.Completo	( ) 6	União Estável	( ) 6	Estudante
( ) 7	Pós-Graduação	( ) 7	Outro	( ) 7	Dona de casa
( ) 8	Analfabeto			( ) 8	Aposentado
( ) 9	Outros			( ) 9	Aposentado por Invalidez
				( ) 10	Outro

Procedência:		**Com quem vive:**		**Renda Individual:**
( ) 1	Porto Alegre	( ) 1	Sozinho	
( ) 2	Grande Porto Alegre	( ) 2	Com os pais	**Renda Familiar:**
( ) 3	Interior	( ) 3	Com o Conjugue	
( ) 4	Outros Estados	( ) 4	Com os filhos	**Residência:**
		( ) 5	Com familiares	(1) Própria
		( ) 6	Numa instituição	(2) Alugada
		( ) 7	Outro	(3) Outro: ________

Pratica alguma religião? () SIM () NÃO Qual?....................

Nível sócio-econômico segundo IBGE:

	Não tem	Tem 1	Tem 2	Tem 3	Tem 4	Tem 5	6 ou +
TV	0	2	4	6	8	10	12
Rádio	0	1	2	3	4	5	6
Banheiro	0	2	4	6	8	10	12
Carro	0	4	8	12	16	16	16
Empregada	0	6	12	18	24	24	24
Telefone	0	5	5	5	5	5	5
Geladeira	0	2	2	2	2	2	2
Instrução do(a) chefe da família				**Pontos**			
Analfabeto/Ensino Fundamental Incompl.				0			
Ensino Fundamental Completo				1			
Ensino Médio Incompleto				3			
Ens. Médio Compl./Ens. Superior Incompl.				5			
Ensino Superior completo				10			

5) Classe A: 35 ou + pontos	2) Classe D: 5-9 pontos
4) Classe B: 21-34 pontos	1) Classe E: 0-4 pontos
3)Classe C: 10-20 pontos	
Total de pontos:	**Classe Social:**

Anexo D – Questionário de Controle Atencional (ACS)

QCA
Questionário de Controle Atencional

Nome: ____________________

Idade: __________ Sexo: ☐ Feminino ☐ Masculino

Anos de Estudo: ________ Profissão: ____________________

Esta escala busca avaliar sua capacidade de controlar a atenção em diversas tarefas do seu dia a dia. Tente ser o mais honesto possível, respondendo a todos os itens abaixo usando os critérios de resposta ao lado de cada item. Ao todo, são quatro opções: 1. quase nunca; 2. às vezes; 3. frequentemente; 4. sempre. Circule a resposta que melhor corresponde ao que você percebe sobre sua capacidade de controlar a atenção. Não há resposta certa ou errada, apenas como você percebe a si mesmo. O preenchimento dura em torno de 10 minutos. Qualquer dúvida, pergunte ao avaliador. Obrigado.

	Quase nunca	Às vezes	Frequentemente	Sempre
1. Tenho dificuldade de me concentrar em uma tarefa difícil quando há muito barulho em volta.	1	2	3	4
2. Quando preciso me concentrar para resolver um problema, tenho dificuldade de focalizar minha atenção.	1	2	3	4
3. Mesmo quando estou concentrado trabalhando em algo, distraio-me com o que está acontecendo em volta.	1	2	3	4
4. Minha concentração é boa mesmo quando há música tocando em um ambiente fechado.	1	2	3	4
5. Quando estou me concentrando, consigo focar a atenção de forma que não percebo mais o que está acontecendo à minha volta em um ambiente fechado.	1	2	3	4
6. Quando estou lendo ou estudando, distraio-me facilmente se há pessoas conversando em um ambiente fechado.	1	2	3	4
7. Quando estou tentando me concentrar em algo, tenho dificuldade para bloquear pensamentos que me distraem.	1	2	3	4
8. Tenho dificuldade de me concentrar quando estou animado com algo.	1	2	3	4
9. Quando estou concentrado, ignoro as sensações de fome e sede.	1	2	3	4
10. Consigo mudar rapidamente de uma tarefa para outra.	1	2	3	4
11. Levo certo tempo para realmente me concentrar em uma nova tarefa.	1	2	3	4
12. Tenho dificuldade de coordenar minha atenção entre as tarefas de ouvir e escrever quando estou fazendo anotações durante uma palestra ou aula.	1	2	3	4
13. Consigo me interessar rapidamente por outro assunto quando necessário.	1	2	3	4
14. Para mim, é fácil ler ou escrever ao mesmo tempo em que falo ao telefone.	1	2	3	4
15. Tenho dificuldade em manter duas conversas ao mesmo tempo.	1	2	3	4
16. Tenho dificuldade de ter novas ideias rapidamente.	1	2	3	4
17. Após ser interrompido ou distraído, consigo facilmente retornar minha atenção para o que estava fazendo.	1	2	3	4
18. Quando fico distraído com um pensamento, é fácil desviar minha atenção dele.	1	2	3	4
19. Para mim, é fácil alternar entre duas tarefas diferentes.	1	2	3	4
20. Para mim, é difícil mudar de uma forma de pensar sobre algo e olhá-lo por outro ponto de vista.	1	2	3	4

ACS - Attentional Control Scale
Translated from English - Derryberry & Reed, 2002

Anexo E – PHQ-9

QUESTIONÁRIO SOBRE A SAÚDE DO/A PACIENTE (PHQ-9)

Nome:	**Data: __/__/__**

Durante as últimas 2 semanas, com que frequência você foi incomodado/a por qualquer um dos problemas abaixo? (Marque sua resposta com "X")

	Nenhuma vez	**Vários dias**	**Mais da metade dos dias**	**Quase todos os dias**
1. Pouco interesse em fazer as coisas	0	1	2	3
2. Sentir-se "para baixo", deprimido/a ou sem perspectiva	0	1	2	3
3. Dificuldade para pegar no sono ou permanecer dormindo, ou dormir mais do que costume	0	1	2	3
4. Sentir-se cansado ou com pouca energia	0	1	2	3
5. Falta de apetite ou comendo demais	0	1	2	3
6. Sentir-se mal consigo mesmo/a - ou achar que você é um fracasso ou que decepcionou sua família ou você mesmo/a	0	1	2	3
7. Dificuldade para se concentrar nas coisas, como ler o jornal ou ver televisão	0	1	2	3
8. Lentidão para se movimentar ou falar, a ponto das outras pessoas perceberem? Ou o oposto - estar tão agitado/a ou irrequieto/a que você fica andando de um lado para o outro muito mais do que o costume	0	1	2	3
9. Pensar em se ferir de alguma maneira ou que seria melhor estar morto/a	0	1	2	3
Soma individual				
			Ecore total	

Se você assinalou qualquer um dos problemas, indique o grau de dificuldade que os mesmos lhe causaram para realizar seu trabalho, tomar conta das coisas em casa ou para se relacionar com as pessoas:

Nenhuma dificuldade	**Alguma dificuldade**	**Muita dificuldade**	**Extrema dificuldade**
❑	❑	❑	❑

Anexo F – PCL-5

PCL 5

<u>Instruções:</u> Este questionário pergunta sobre dificuldades que você possa ter enfrentado após uma experiência muito traumatizante envolvendo *morte ou ameaça de morte, ferimentos graves ou violência sexual*. Tal experiência pode ser algo que aconteceu diretamente com você, ser uma situação que você presenciou ou algo que você soube que aconteceu com um membro próximo da sua família ou um amigo próximo. Alguns exemplos são: *acidente grave; incêndio; desastre, como enchente, deslizamento de terra, desabamento; agressão ou abuso físico ou sexual; guerra; homicídio ou suicídio*.

Em primeiro lugar, por favor, responda a algumas perguntas sobre o pior evento da sua vida, o que para este questionário, significa o evento que mais lhe incomoda atualmente. Esse evento pode ser um dos exemplos acima ou alguma outra experiência muito traumatizante. Além disso, pode ser um único evento (por exemplo, um acidente de carro) ou vários eventos semelhantes (por exemplo, vários eventos traumatizantes em uma área de guerra ou abuso sexual repetido).

1. ***Descreva resumidamente o pior evento (se você se sentir à vontade para fazer isso):*** ____

2. ***Há quanto tempo o evento aconteceu?*** _______________***(Por favor, calcule o tempo aproximado se você não tiver certeza).***

3. ***O evento envolveu morte ou risco de morte, ferimentos graves ou violência sexual?***

   a) Sim

   b) Não

4. Como você vivenciou o evento?

   a) Aconteceu diretamente comigo

   b) Eu presenciei o evento

   c) Eu fiquei sabendo que este evento aconteceu com um membro próximo da minha família ou um amigo próximo

   d) Eu fui repetidamente exposto a detalhes do evento como parte do meu trabalho (por exemplo, paramédico, policial, militar ou outro tipo de socorrista)

   e) Outro, por favor, descreva: ____

5. ***Se o evento envolveu a morte de um membro próximo da sua família ou amigo próximo, foi devido a algum tipo de acidente ou violência, ou foi devido a causas naturais?***

   a) Acidente ou violência

   b) Causas naturais

   c) Não se aplica (o evento não envolveu a morte de um membro próximo da minha família ou amigo próximo)

Em segundo lugar, mantendo o seu pior evento em mente, por favor, leia cuidadosamente cada uma das dificuldades listadas na próxima página e então circule um dos números à direita para indicar o quanto você tem se sentido incomodado por essa dificuldade <u>no último mês</u>.

No último mês, quanto você se sentiu incomodado por:	*Absoluta-mente nada*	*Um pouco*	*Moderada-mente*	*Muito*	*Extrema-mente*
1. Lembranças repetidas, perturbadoras e involuntárias da experiência traumatizante.	**0**	**1**	**2**	**3**	**4**
2. Sonhos repetidos e perturbadores referentes à experiência traumatizante.	**0**	**1**	**2**	**3**	**4**
3. De repente, se sentir ou agir como se a experiência traumatizante estivesse realmente acontecendo de novo (como se você estivesse lá de volta revivendo a situação).	**0**	**1**	**2**	**3**	**4**
4. Sentir-se muito perturbado quando algo lhe faz lembrar da experiência traumatizante.	**0**	**1**	**2**	**3**	**4**
5. Apresentar reações físicas intensas quando algo lhe faz lembrar da experiência traumatizante (por exemplo, coração bater forte, dificuldades para respirar, suor excessivo).	**0**	**1**	**2**	**3**	**4**
6. Evitar lembranças, pensamentos ou sentimentos relacionados à experiência traumatizante.	**0**	**1**	**2**	**3**	**4**
7. Evitar algo ou alguém que lembre você da experiência traumatizante (por exemplo, pessoas, lugares, conversas, atividades, objetos ou situações).	**0**	**1**	**2**	**3**	**4**
8. Dificuldades de se lembrar de partes importantes da experiência traumatizante.	**0**	**1**	**2**	**3**	**4**
9. Ter fortes crenças negativas sobre si mesmo, sobre outras pessoas ou sobre o mundo (por exemplo, ter pensamentos como: eu sou ruim, há algo muito errado comigo, não se pode confiar em ninguém, o mundo é um lugar muito perigoso).	**0**	**1**	**2**	**3**	**4**
10. Culpar a si mesmo ou a outra pessoa pela experiência traumatizante ou pelo que aconteceu depois de tal experiência.	**0**	**1**	**2**	**3**	**4**
11. Ter fortes sentimentos negativos, tais como medo, horror, raiva, culpa ou vergonha	**0**	**1**	**2**	**3**	**4**
12. Perder o interesse em atividades que você costumava gostar.	**0**	**1**	**2**	**3**	**4**
13. Sentir-se distante ou isolado das outras pessoas.	**0**	**1**	**2**	**3**	**4**
14. Dificuldades para experimentar sentimentos positivos (por exemplo, ser incapaz de sentir felicidade ou de ter sentimentos afetuosos pelas pessoas próximas a você).	**0**	**1**	**2**	**3**	**4**
15. Comportamento irritável, explosões de raiva, ou agir de forma agressiva.	**0**	**1**	**2**	**3**	**4**
16. Arriscar-se muito ou fazer coisas que podem causar algum mal a você.	**0**	**1**	**2**	**3**	**4**
17. Estar "superalerta" ou hipervigilante.	**0**	**1**	**2**	**3**	**4**
18. Sentir-se sobressaltado ou assustar-se facilmente.	**0**	**1**	**2**	**3**	**4**
19. Ter dificuldades para se concentrar.	**0**	**1**	**2**	**3**	**4**
20. Dificuldades para "pegar no sono" ou para permanecer dormindo.	**0**	**1**	**2**	**3**	**4**

PCL-5 (8/14/2013) Weathers, Litz, Keane, Palmieri, Marx, & Schnurr -- National Center for PTSD
Traduzido e adaptado (18/10/15) por Lima, Vasconcelos, Berger, Kristensen, Nascimento, Figueira, & Mendlowicz.

Anexo G – IDATE (STAI)

QUESTIONÁRIO DE AUTO-AVALIAÇÃO

PARTE I – IDATE ESTADO

Leia cada pergunta e faça um círculo ao redor do número à direita da afirmação que melhor indicar como você se sente agora, neste momento.

Não gaste muito tempo numa única afirmação, mas tente dar uma resposta que mais se aproxime de como você se sente neste momento.

AVALIAÇÃO

Muitíssimo-------4 Umpouco ---------------------2

Bastante---------3 Absolutamentenão------------1

1- Sinto-me calmo	1	2	3	4
2- Sinto-me seguro	1	2	3	4
3- Estou tenso	1	2	3	4
4- Estou arrependido	1	2	3	4
5- Sinto-me à vontade	1	2	3	4
6- Sinto-me perturbado	1	2	3	4
7- Estou preocupado com possíveis infortúnios	1	2	3	4
8- Sinto-me descansado	1	2	3	4
9- Sinto-me ansioso	1	2	3	4
10- Sinto-me "em casa"	1	2	3	4
11- Sinto-me confiante	1	2	3	4
12- Sinto-me nervoso	1	2	3	4
13- Estou agitado	1	2	3	4
14- Sinto-me uma pilha de nervos	1	2	3	4
15- Estou descontraído	1	2	3	4
16- Sinto-me satisfeito	1	2	3	4
17- Estou preocupado	1	2	3	4
18- Sinto-me confuso	1	2	3	4
19- Sinto-me alegre	1	2	3	4
20- Sinto-me bem	1	2	3	4

PARTE II – IDATETRAÇO

Leia cada pergunta e faça um círculo em redor do número à direita que melhor indicar como você geralmente se sente.

Não gaste muito tempo numa única afirmação, mas tente dar a resposta que mais se aproximar de como você se sentegeralmente.

AVALIAÇÃO

Quasesempre-------4 Àsvezes --------------------- 2
Frequentemente-----3 Quasenunca ------------------1

1. Sinto-me bem	1	2	3	4
2. Canso-me facilmente	1	2	3	4
3. Tenhovontade de chorar	1	2	3	4
4. Gostaria de poder ser tão feliz quanto os outros parecem ser	1	2	3	4
5. Perco oportunidades porque não consigo tomar decisões rapidamente	1	2	3	4
6. Sinto-me descansado	1	2	3	4
7. Sou calmo, ponderado e senhor de mim mesmo	1	2	3	4
8. Sinto que as dificuldades estão se acumulando de tal forma que não as consigo resolver	1	2	3	4
9. Preocupo-me demais com as coisas sem importância	1	2	3	4
10. Sou feliz	1	2	3	4
11. Deixo-me afetar muito pelas coisas	1	2	3	4
12. Não tenho muita confiança em mim mesmo	1	2	3	4
13. Sinto-me seguro	1	2	3	4
14. Evito ter que enfrentar crises ou problemas	1	2	3	4
15. Sinto-me deprimido	1	2	3	4
16. Estou satisfeito	1	2	3	4
17. Idéias sem importância me entram na cabeça e ficam me preocupando	1	2	3	4
18. Levo os desapontamentos tão a sério que não consigo tirá-los da cabeça	1	2	3	4
19. Souumapessoaestável	1	2	3	4
20. Fico tenso e perturbado quando penso em meus problemas do momento	1	2	3	4

Glossário

ABT – Attentional Bias relative to Threat

ABV – Attentional Bias Variability

AC – Attentional Control

ACC – Anterior Cingulate Cortex

ACS – Attentional Control Scale

ADHD – Attention Deficit Hyperactivity Disorder

AOI – Area of Interest (of gaze orientation)

DPT – Dot-Probe Task

EF – Executive Function

EST – Emotional Stroop Task

fMRI – Functional Magnetic Resonance Imaging

FV – Free Visualization Period

FV-ABV – Attentional Bias Variability in the Free Visualization Period

GAD – General Anxiety Disorder

HRV – Heart Rate Variability

MDD – Major Depressive Disorder

OR – Orienting Response

PCL-5 – PTSD Checklist

PHQ-9 – Patient Health Questionnaire

PP – Post-Probe Onset Period

PP-ABT – Attentional Bias relative to Threat in the Post-Probe Onset Period

PP-ABV – Attentional Bias Variability in the Post-Probe Onset Period

PTSD – Posttraumatic Stress Disorder

PTSS – Posttraumatic Stress Symptoms

RT – Reaction Time

SAS – Supervisory Attentional System

STAI-S – State-Trait Anxiety inventory – State

STAI-T – State-Trait Anxiety inventory – Trait

T1 and **T2** – First and second experimental sessions (respectively)

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