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The impact of chronic alcohol consumption on response inhibition and self-control functions.

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Theoretical Contextualization

According to the World Health Organization (WHO), an alcoholic is defined as an individual who consumes alcohol excessively and whose dependence is associated with mental disorders, physical health problems, difficulties in interpersonal relationships and changes in social and economic behavior (Oliveira et al., 2022). In recent years, alcohol consumption has increased significantly, with this growth being more pronounced in developing countries. Excessive alcohol consumption is recognized as the fifth risk factor for premature deaths and disabilities worldwide, including liver conditions, nutritional deficiencies and various types of cancer. In addition, it is directly related to chemical dependency and the increased occurrence of episodes of violence and accidents (Mello et al., 2001). It is also widely associated with deficits in executive functions, especially in response inhibition, which is the ability to suppress inappropriate impulses or automatic actions. This function is essential for self-control and is mainly mediated by the prefrontal cortex, a region frequently compromised in individuals with Alcohol Use Disorder (AUD). Neuropsychological studies show that individuals with alcohol dependence have significant difficulties in tasks that require response inhibition, such as the Go/No-Go task. These deficits are associated with changes in the functioning of the prefrontal cortex, responsible for impulse control and decision-making (Nogueira et al., 2021).

Alcohol Use Disorder (PUA)

PUA is defined by a set of cognitive, behavioral and physical symptoms resulting from continued and excessive alcohol consumption (Reis et al., 2021). It is considered a psychiatric disorder characterized by the presence of impulsive and/or compulsive behaviors. Impulsive behaviors are associated with the immediate search for reward provided by alcohol consumption, prevailing over long-term benefits and therefore becoming difficult to control. Compulsive behaviors emerge from a pattern of consumption initially motivated by reward, but which evolves into a rigid habit, the interruption of which becomes challenging due to its function of alleviating tension and mitigating withdrawal symptoms. This condition is sustained by a dysregulation of corticostriatal circuits (Feldens, 2009). The compulsivity associated with PUA is evidenced by the hyperactivation of the frontostriatal circuit, which includes the medial prefrontal cortex, the anterior insular cortex and the striatum, in individuals with PUA.

excessive alcohol consumption or diagnosed with severe PUA. Globally, the prevalence of PUA is estimated at 3.6%, making it the most prevalent substance use disorder worldwide.

Problem Formulation

Chronic alcohol consumption is widely recognized as a determinant of significant alterations in neurocognitive functions, with a particular impact on executive control processes (Willhelm et al., 2018; Bogenschutz et al., 2022). Despite the extensive literature associating alcohol consumption with cognitive dysfunction, there are gaps in the precise and mechanistic understanding of the specific impact of this consumption on response inhibition and self-control functions in clinical populations. These capacities, fundamental for behavioral regulation and adaptive decision-making, are often compromised in individuals exposed to prolonged alcohol consumption, resulting in greater susceptibility to impulsivity, compulsivity and dysfunctional behavioral patterns.

The Go/No-Go task is a validated experimental tool for assessing response inhibition and represents a reliable method for empirically investigating changes in the neural circuits underlying executive control (Feldens, 2009). However, the impact of chronic alcohol consumption on these functions, assessed through this experimental paradigm, remains underexplored and poorly understood in clinical populations. This research aims to fill some of these gaps by systematically and methodologically investigating the influence of chronic alcohol consumption on response inhibition and self-control mechanisms using the Go/No-Go task.

In order to deepen knowledge about the effects of chronic alcohol consumption on executive functions, a general objective was created:**Understand the impact of this behavior on response inhibition and self-control functions in clinical populations,**and several specific objectives:

1. **To evaluate the performance of individuals with chronic alcohol consumption in Go/No-Go tasks. - Go**, with an emphasis on the accuracy of responses and reaction speed, in order to identify possible deficits related to cognitive processing.
2. **To compare response inhibition patterns between individuals with chronic alcohol consumption alcohol and a healthy control group**, using specific indicators of Go/No-Go tasks, such as response time measures, hit rate and error frequency.
3. **Investigate the relationship between the degree of alcohol dependence and the frequency of errors (errors commission and omission) in Go/No-Go tasks**, in order to explore the association between the severity of dependence and the impairment of response inhibition functions.

The intention of this research is to stand out for its innovation, firstly, in terms of filling gaps in the literature by systematically exploring the impact of chronic alcohol consumption on response inhibition and self-control functions in clinical populations, using the Go/No-Go task (Feldens, 2009), contributing to the development of therapeutic interventions, offering valuable data that can support cognitive rehabilitation strategies and personalized treatments and finally, demonstrating that the application of the Go/No-Go task in clinical settings reinforces its validity as an instrument in neuropsychology, expanding its use in assessment and intervention contexts.

Hypotheses

In terms of Hypotheses that derive from the research question, it seems important to mention: **H1.**

Individuals with Alcohol Use Disorder (AUD) will show a higher rate of commission and omission errors in the Go/No-Go task compared to the control group, indicating significant deficits in response inhibition.

H2. The severity of alcohol dependence correlates positively with the frequency of errors in the Go/No-Go task, especially in blocks that require changes in the response pattern (shift blocks).

H3.EEG will show a lower amplitude of event-related potentials (ERPs) in the prefrontal cortex in participants with PUA during response inhibition stimuli, indicating dysfunction in this region.

H4. Individuals with PUA will have slower reaction times to neutral stimuli compared to alcohol-related stimuli, suggesting an attentional bias.

Methodology

To conduct this experimental, cross-sectional research, focused on evaluating the impact of chronic alcohol consumption on response inhibition and self-control functions in clinical populations, the researcher used:

1. **Socio-Demographic Data Questionnaire**–objective tool identify variables related to the social, economic and demographic profile (Cunha et al., 2024).
2. **Wechsler Adult Intelligence Scale**-WAIS III - David's Intelligence Scale Wechsler (Figueiredo & Nascimento, 2007)
3. ***Alcohol-Shifting Task***, an adapted version of the original task developed by Murphy et al. (1999).
4. **Electroencephalogram (EEG)**–Laboratory technique (Siuly & Zhang, 2016).

Alcohol-Shifting Task

This instrument was used as the main tool to assess executive functions, integrating behavioral and neurocognitive analyses, as described by Noël et al. (2007). The combination of these instruments allows to obtain a comprehensive view of the participants' profile (sociodemographic and cognitive data) and to focus specifically on the neurocognitive and behavioral mechanisms (Alcohol-Shifting Task) impacted by chronic alcohol consumption.

To program Go/No-Go tasks, such as the one mentioned, SuperLab 6 Software will be used. This is an advanced software for the design and management of experiments in psychology and neuroscience, characterized by the precision in the presentation of stimuli and the collection of data. It supports a wide variety of stimuli, including text, images, audio, videos and rapid serial presentation (RSVP), allowing the creation of complex experimental protocols without the need for programming. Data collection can be performed via keyboard, mouse, response pads or microphone, and the software integrates with external devices, such as EEG and fMRI systems, for the precise synchronization of event markers. The experimental control includes functionalities for stimulus randomization, real-time feedback, use of lists and sublists, and application of conditional rules. In addition, SuperLab Remote allows the conduct of remote studies, collecting centralized data.

Compatible with Windows and macOS, the software features an intuitive menu-based interface and drag-and-drop options. It is widely used in behavioral and neuroscience studies due to its flexibility, integration with devices such as eye trackers and response pads, and robust tools for experimental control and analysis. SuperLab 6 is an effective and versatile solution for researchers who require high precision and customization when conducting experimental studies (Cunha et al., 2024).

THE*Alcohol-Shifting Task*is based on Go/No-Go tasks, in which words are briefly presented, one by one, in the center of the screen. Half of the words are designated as targets and the other half as distractors. Participants must respond quickly to the targets by pressing the space bar, but inhibit any response to the distractors. Each word is displayed for 500 ms, with a 900 ms interval between stimuli (Noël et al., 2007).

A 500 ms tone at 450 Hz is emitted to signal false alarm errors (response to a distractor), while omissions (failure to respond to a target) do not trigger any sound. The task includes two practice blocks, followed by eight test blocks, each with 18 stimuli, divided into nine neutral (N) and nine alcohol-related (A) words. In each block, the words N or A are designated as targets. The order of presentation of the targets follows a fixed pattern across the blocks, alternating between NNAANNAANN or AANNAANNAA. Thus, four blocks are classified as “non-shift,” in which participants maintain the same response pattern, and another four as “shift,” requiring participants to respond to stimuli previously categorized as distractors and inhibit responding to stimuli previously considered targets.

According to the authors Noël et al. (2007) the 45 neutral and alcohol-related words were selected from an initial list of 180 words. The selection was based on evaluations made by five certified psychologists (Department of Psychology of the Free University of Brussels) and 30 alcoholic patients undergoing detoxification treatment (Brugmann University Hospital, Addiction Clinic) (decencies). Assessments should be performed blindly to the purpose of the study, using a 7-point Likert scale, with extremes from -3 (“very unrelated to alcohol”) to +3 (“very related to alcohol”). Words classified as -3/-2 were considered alcohol-related, while those with +2/+3 were categorized as neutral. Neutral and alcohol-related words did not show significant differences in length or frequency, according to the standards of Hofland and Johansson (1982). Examples of alcohol-related words include “drink”, “drunk” and “cocktail”; examples of neutral words include “forest”, “closet” and “port” (Noël et al., 2007).

Electroencephalogram

To complement the research presented, it is considered to use the biometric and neurophysiological technique**Electroencephalogram**as a way to explore additional dimensions of the impact of chronic alcohol consumption on executive functions, particularly response inhibition and self-control. Electroencephalography (EEG) is a non-invasive neurophysiological technique that records brain electrical activity through electrodes on the scalp. Widely used in research and clinical diagnosis, EEG allows the analysis of brain functions and responses to stimuli, providing essential data for the study of complex processes in neuroscience (Luck, 2014; Schomer & Lopes da Silva, 2017; Santos & Coutinho, 2024). Due to its sensitive nature and the involvement of human beings, the use of EEG should be guided by rigorous good practice protocols that ensure data quality and safeguard the well-being of participants (Sanei & Chambers, 2007). According to Im (2018) and Sazgar & Young (2019), EEG equipment consists of an Electrode Helmet, a structure that contains electrodes at specific points on the scalp, according to standard positioning systems (e.g., 10-20 system), allowing consistent and accurate capture of brain activity. They are available in different sizes and configurations to better adapt to the needs of the participants and the experimental protocol.

Electrodes are small devices that interface directly with the scalp, capturing brain electrical activity. These can be disposable or reusable, and it is essential that they are positioned according to protocols to ensure data validity. Conductive Paste or Gel is a conductive material that improves the quality of the connection between the electrode and the scalp, ensuring a more accurate reading of electrical signals. Given that brain electrical activity is of low amplitude, the amplifier is essential to increase the power of the signals, allowing a reliable and detailed reading. To facilitate reading, researchers use Data Collection and Analysis Software that monitors, records and processes signals in real time. It allows the application of filters and the segmentation of data for analysis according to the needs of the study. Obviously, the software is run through a computer where the data is analyzed. In controlled experiments, the computer can also present stimuli and record responses synchronized with EEG activity. Finally, but no less important, an Artifact Monitoring System (cameras or motion sensors) is also used, capable of monitoring the environment and minimizing sources of noise or interference, such as participant movements (Santos & Coutinho, 2024).

To ensure data validity and safety when conducting EEG experiments, it is essential to implement rigorous best practices at all stages of the process (Chatrian et al., 1985; Delorme & Makeig, 2004; Luck, 2014; APA, 2017). One of the first steps is Participant Preparation by obtaining Informed Consent before the process begins.

Skin Preparation, used to reduce resistance between the electrodes and the scalp, may include gently cleaning the area with an appropriate solution, such as alcohol, to ensure good conductivity. Proper Electrode Positioning should also be performed according to 10-20 system standards, ensuring that the data collected are consistent and comparable between different studies. A second stage involves Equipment Configuration in the form of Calibration and Pre-Experiment Testing to ensure accurate signal capture. Checking the resistance of the electrodes and their suitability are routine procedures. All Artifacts should be properly controlled in order to minimize interference in the EEG signal, eliminating sources of electrical noise and moving devices (Ferreira et al, 2022). It is important to ensure that the participant is comfortable and instructed to avoid sudden movements that may interfere with data collection. This should be done through Real-Time Monitoring in order to avoid technical problems, such as dislodged electrodes or interference, and correct them immediately, avoiding data loss. The use of event markers is crucial to synchronize the presentation of stimuli with the EEG recording, facilitating the analysis of specific brain responses. Minimizing Physiological artifacts such as blinking or head movement can introduce noise into the EEG data. The The participant should be instructed to minimize these movements (Santos & Coutinho, 2024). In terms of Finalization Procedures, it is important to perform a Safe Removal so as not to cause discomfort to the participant. After each use, the electrodes and the helmet must be properly sanitized. Data Storage and Analysis requires the researcher to respect data protection and confidentiality regulations. Before final analysis, the data must be carefully inspected to identify and remove undesirable artifacts, such as low-frequency noise, muscle or movement interference. To finalize the raw EEG files and subsequent analyses, they must be properly organized and subject to regular backups, avoiding data loss and facilitating future access (Chatrian et al., 2024).

al., 1985; Delorme & Makeig, 2004; Luck, 2014).

Sample

Regarding the sample, it is expected that 60 participants will be included, divided into two groups. An Experimental group with 30 individuals diagnosed with Alcohol Use Disorder (AUD), according to DSM-5 criteria, and a Control group also with 30 healthy individuals, matched by age, gender and educational level.

In terms of Inclusion Criteria and with regard to the experimental group:

I) PUA diagnosis confirmed by clinical evaluation.

II) Age between 18 and 60 years.

III) Abstinence from alcohol for at least 72 hours (to avoid acute effects of consumption). For the control group:

1. Absence of history of dependence on alcohol or other substances (except tobacco).
2. Absence of diagnosed psychiatric conditions.

Regarding Exclusion Criteria (for both groups):

THE. History of traumatic brain injury or neurological disease.

B. Current use of psychotropic medication.

W. Sensory or motor deficits that make it difficult to perform the Go/No-Go task.

Compliance with scientific and ethical requirements

This research guarantees the confidentiality and protection of the identity of the participants through the pseudonymization of the data collected. These will be used exclusively within the scope of this study and in future research whose objectives are aligned with the same theme. Access to the data will be restricted to the researchers directly involved in the research, including questionnaires, audiovisual files and physical processes, ensuring confidentiality at all stages of the work.

In scientific publications resulting from this study, the identity of participants will be strictly protected, and no information that allows their identification will be disclosed.

The processing of personal data follows the guidelines established in the General Data Protection Regulation (EU Regulation 2016/679) of the European Parliament and the Council, as well as the parameters defined in Deliberation 1704/2015 of the National Data Protection Commission (CNPD), applicable to the processing of data in the context of research studies. Additionally, the practices adopted are aligned with the ethical and deontological precepts established by the Code of Ethics of the Portuguese Order of Psychologists. All participants will be informed of their right to lodge complaints with the CNPD, should they identify possible irregularities.

This study fully complies with the ethical principles defined in the Declaration of Helsinki, recognized globally as a reference for conducting scientific and clinical research. Before participating, each individual will be duly informed about the objectives, procedures and potential implications of the study, and will be asked to sign an informed consent form, confirming their understanding and acceptance of the conditions of participation.

Conclusion

The present investigation, focused on the impact of chronic alcohol consumption on response inhibition and self-control functions, using Go/No-Go tasks, highlights relevant implications for neuropathy. clinical psychology and for professional practice. The results to be projected deepened the understanding of the neurocognitive deficits associated with Alcohol Use Disorder (AUD), with particular focus on dysfunctions of executive functions mediated by the prefrontal cortex. This multidimensional approach will provide a solid theoretical and empirical basis for the development of innovative and personalized therapeutic strategies.

In the context of clinical neuropsychology, the use of the Go/No-Go task and EEG will demonstrate potential as a rigorous and sensitive methodology for the assessment of inhibitory control in populations with PUA. By identifying specific patterns of performance and neurophysiological changes, this research may contribute to a more detailed characterization of the cognitive dysfunctions associated with drug use.

chronic alcohol abuse, particularly in the early stages of the disorder. This methodological advance is crucial for the development of more accurate assessment instruments capable of accurately monitoring cognitive changes over time.

From an applied perspective, the results of this research may support the design of specific cognitive rehabilitation interventions. Strategies based on neurophysiological biofeedback, associated with adaptive Go/No-Go tasks, may be explored to strengthen inhibitory control and mitigate impulsivity. It may also support the personalization of therapeutic interventions, adjusting methodologies to the severity of each patient's cognitive deficits.

Finally, the implications of this research are expected to extend to the training of professionals and the definition of public policies. By reinforcing the relevance of neuropsychological assessment in the treatment of addictions, this research highlights the need to integrate evidence-based methods in the development of more effective preventive and therapeutic interventions, contributing to a more informed professional practice and a more targeted and well-founded clinical intervention.

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