THE IMPACT OF CHRONIC ALCOHOL CONSUMPTION ON RESPONSE INHIBITION AND SELF-CONTROL FUNCTIONS

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ABSTRACT

The paper explores the impact of chronic alcohol consumption on executive functions, particularly response inhibition and self-control, highlighting Alcohol Use Disorder (PUA) and the use of the Go/No-Go task to assess these functions. The research aims to fill gaps in the literature and contribute to more effective treatments.

Keywords: Alcohol consumption. Response inhibition.

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THEORETICAL CONTEXTUALIZATION

According to the World Health Organization (WHO), an alcoholic is defined as an individual who consumes alcohol in excess 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, covering liver conditions, nutritional deficiencies and various types of cancers. In addition, it is directly related to chemical dependence and the increase in the occurrence of episodes of violence and accidents (Mello et al., 2001). It is also widely associated with deficits in executive functions, especially response inhibition, which is the ability to suppress inappropriate impulses or automatic actions. This function is essential for self-control and is mediated primarily by the prefrontal cortex, a region often compromised in individuals with Alcohol Use Disorder (PUA). Neuropsychological studies have shown that individuals with alcohol dependence have significant difficulties in tasks that require inhibition of responses, such as the Go/No-Go task. These deficits are associated with changes in the functioning of the prefrontal cortex, which is responsible for impulse control and decision-making (Nogueira et al., 2021).

ALCOHOL USE DISORDER (APU)

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 demand for reward provided by alcohol consumption, prevailing over the long-term benefits and therefore becoming difficult to control. Compulsive behaviors emerge from a consumption pattern initially motivated by reward, but which evolves into a rigid habit, whose interruption becomes challenging due to its function of attenuating tension and mitigating withdrawal symptoms. This is supported by a dysregulation of the cortico-striatal circuits (Feldens, 2009). Compulsivity associated with PUA is evidenced by hyperactivation of the fronto-striated circuit, which includes the medial prefrontal cortex, anterior insular cortex, and striatum, in individuals with excessive alcohol consumption or with a diagnosis of severe PUA. Globally, it is estimated that the prevalence of PUA is 3.6%, which is the most prevalent substance use disorder worldwide.

FORMULATION OF THE PROBLEM

Chronic alcohol consumption is widely recognized as a determinant of significant changes 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 still 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 abilities, which are fundamental for behavioral regulation and adaptive decision-making, are often compromised in individuals exposed to long-term alcohol consumption, resulting in increased susceptibility to impulsivity, compulsivity, and dysfunctional behavioral patterns.

The Go/No-Go task is a validated experimental tool for the assessment of response inhibition, it represents a reliable method for the empirical investigation of 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 proposes to fill some of these gaps by investigating, in a systematic way and with methodological rigor, the influence of chronic alcohol consumption on response inhibition and self-control mechanisms, using the Go/No-Go task.

In order to deepen the knowledge about the effects of chronic alcohol consumption on executive functions, a general objective was created: **To 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**, with 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 and a healthy control group**, using indicators specific to Go/No-Go tasks, such as measures of response time, hit rate, and frequency of errors.
3. **To investigate the relationship between the degree of alcohol dependence and the frequency of errors (commission errors and omissions) in Go/No-Go tasks**, in order to explore the association between the severity of dependence and the impairment of response inhibition functions.

It is the intention of this research 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), to contribute to the development of therapeutic interventions, offering valuable data that can support cognitive rehabilitation strategies and personalized treatments and finally, to demonstrate that the application of the Go/No-Go task in clinical scenarios 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 (AUP) will have a higher rate of commission errors and omissions 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 for neutral stimuli compared to alcohol-related stimuli, suggesting 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** – tool aimed at identifying variables related to social, economic, and demographic profile (Cunha et al., 2024).
2. **Wechsler Intelligence Scale for Adults** - WAIS III - David Wechsler Intelligence Scale (Figueiredo & Nascimento, 2007)
3. ***Alcohol-Shifting Task***, an adapted version of the original task developed by Murphy et al. (1999).
4. **Eletroencefalograma (EEG)** – Técnica laboratorial (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 us to obtain a comprehensive view of the participants' profile (socio-demographic 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, the SuperLab 6 Software will be used, which is an advanced software for the design and management of experiments in psychology and neurosciences, characterized by precision in the presentation of stimuli and data collection. 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 accurate synchronization of event markers. The experimental control includes features for stimulus randomization, real-time feedback, use of lists and sublists, and application of conditional rules. In addition, SuperLab Remote allows remote studies to be carried out by collecting centralized data.

Compatible with Windows and macOS, the software has an intuitive menu-based interface and drag-and-drop options. It is widely used in behavioral and neuroscientific 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 need 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 displayed, 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 targets by pressing the space bar, but inhibit any response to distractors. Each word is displayed for 500 ms, with an interval of 900 ms 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 words (N) and nine alcohol-related words (A). In each block, the words N or A are designated as targets. The order of presentation of the targets follows a fixed pattern along the blocks, alternating between NNAANNAANN or AANNAANNAA. Thus, four

blocks are classified as "non-shift", in which the participants maintain the same response pattern, and another four as "shift", requiring the participants to start responding to stimuli previously categorized as distractors and inhibit the response 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 carried out on the basis of 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). Evaluations should be carried out blindly to the study objective, using a 7-point Likert scale, with extremes from -3 ("very unrelated to alcohol") to +3 ("very related to alcohol"). Words rated with -3/-2 were considered alcohol-related, while those rated +2/+3 were categorized as neutral. The neutral and alcohol-related words did not present significant differences in length or frequency, according to the norms 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, the use of the biometric and neurophysiological technique **Electroencephalogram** is considered 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 neurosciences (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 strict protocols of good practice, which ensure the quality of the data and safeguard the well-being of the participants (Sanei & Chambers, 2007). According to Im (2018) and Sazgar & Young (2019), the EEG equipment is composed of electrodes in specific points of the scalp, according to standard positioning systems (e.g., 10-20 system), allowing the consistent and accurate capture of brain activity, 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, picking up electrical activity in the brain. These can be disposable and reusable, and it is essential that they are positioned according to the protocols to ensure the validity of the data. Conductive Paste or Gel is a conductive material that improves the quality of the bond between the electrode and the scalp, ensuring a more accurate reading of electrical signals. Since the brain's electrical activity is of low amplitude, the amplifier is essential to increase the power of the signals, allowing a reliable and detailed reading. To make reading easier, researchers use Data Collection and Analysis Software that monitors, records and processes signals in real time. It allows the application of filters and data segmentation 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. Last but not least, 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 participants' movements (Santos & Coutinho, 2024).

To ensure the validity of the data and the safety of conducting EEG experiments, it is critical to implement rigorous good practices at all stages of the process (Chatrian et al., 1985; Delorme & Makeig, 2004; Luck, 2014; APA, 2017). One of the first steps is the Preparation of the Participants by making an Informed Consent before the start of the process.

Skin Preparation, used to reduce the resistance between the electrodes and the scalp, may include gently cleansing the area with an appropriate solution, such as alcohol, to ensure good conductivity. Also Proper Electrode Positioning should be performed according to system 10-20 standards, ensuring that the data collected are consistent and comparable across different studies. A second moment goes through the Equipment Configuration in the form of Calibration and Pre-Experiment Tests in order to ensure the accurate capture of the signals. Checking the resistance of the electrodes and their suitability is routine procedure. All Artifacts must be properly controlled as a way to minimize interference with the EEG signal, eliminating sources of electrical noise and mobile devices (Ferreira et al, 2022). It is important to ensure that the participant is comfortable and instructed to avoid sudden movements that could 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 it 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 wiggle can introduce noise into the EEG data. The participant should be instructed to minimize these movements (Santos & Coutinho, 2024). In terms of Completion Procedures, it is important to perform a Safe Removal in order not to cause discomfort to the participant. After each use, the electrodes and helmet must be properly sanitized. Data Storage and Analysis leads the researcher to respect data protection and confidentiality regulations. Before final analysis, the data should be carefully inspected to identify and remove undesirable artifacts, such as low-frequency noise, muscle interference, or movement. To finish, raw EEG files and subsequent analyses must be properly organized and subject to regular backups, preventing data loss and facilitating future access (Chatrian et al., 1985; Delorme & Makeig, 2004; Luck, 2014).

SAMPLE

With regard to the sample, it is expected to include 60 participants, divided into two groups. An Experimental group with 30 individuals diagnosed with Alcohol Use Disorder (PUA), 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) Diagnosis of PUA 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 a history of dependence on alcohol or other substances (except tobacco).
2. Absence of diagnosed psychiatric conditions.

With regard to Exclusion Criteria (for both groups):

A. History of traumatic brain injuries or neurological diseases.

B. Current use of psychotropic medication.

C. 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 data will be restricted to researchers directly involved in the research, including questionnaires, audiovisual files and physical files, ensuring confidentiality at all stages of the work.

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

The processing of personal data follows the guidelines established in the General Data Protection Regulation (EU Regulation 2016/679) of the European Parliament and of the Council, as well as the parameters defined in Resolution 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 in line with the ethical and deontological precepts established by the Code of Ethics of the Order of Portuguese Psychologists. All participants will be informed of their right to file complaints with the CNPD, if they identify possible irregularities.

This study fully respects 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 research, focused on the impact of chronic alcohol consumption on response inhibition and self-control functions, using Go/No-Go tasks, shows relevant implications for clinical neuropsychology and professional practice. The results to be projected deepened the understanding of the neurocognitive deficits associated with Alcohol Use Disorder (PUA), with a 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 evaluation of inhibitory control in populations with PUA. By identifying specific performance patterns and neurophysiological changes, this research may contribute to a more detailed characterization of the cognitive dysfunctions associated with chronic alcohol consumption, particularly in the early stages of the disorder. This methodological advance is crucial for the

development of more accurate assessment instruments, capable of rigorously monitoring cognitive changes over time.

From an applied point of view, 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, can 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, it is intended that the implications of this research 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 underlines 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 reasoned clinical intervention.

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