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Original article

Ecological relevance of the Iowa gambling task in patients with Alzheimer's disease and mild cognitive impairment

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ABSTRACT

Background. – In spite of their extensive use, the ecological relevance of tasks dedicated to assessing real-world decision-making in a laboratory setting remains unclear.
Objectives. – Our study aimed to evaluate the relationship between decision-making and behavioral competency and awareness of limitations.
Methods. – A total of 20 patients with Alzheimer's disease (AD), 20 with amnestic mild cognitive impairment (aMCI) and 20 healthy controls (HC) were assessed for decision-making using the Iowa Gambling Task (IGT). Behavioral competency was evaluated by the Patient Competency Rating Scale (PCRS), which requires each participant and a relative to answer the same 30 questions on participant's competency and to rate each item, while awareness of limitations was evaluated by subtracting the self-rated score from the relative-rated score.
Results. – Using the median-split approach, the proportion of disadvantageous decision-makers was higher in both the MCI and AD groups than in HC ($P = 0.02$ and $P = 0.03$, respectively), with no differences between clinical groups. The percentage of participants with poorer behavioral competency was also higher in the MCI and AD than in the HC (self-rated: $P = 0.025$ and $P = 0.01$, respectively; relative-rated: $P = 0.008$ and $P = 0.008$, respectively), again with no differences between MCI and AD. All groups were comparable in awareness. For all participants, disadvantageous decision-making was associated with both reduced behavioral competency and poor awareness of limitations (OR: 3.47, $P = 0.03$ and OR: 5.4, $P = 0.004$, respectively).
Conclusion. – Our findings support the ecological relevance of the IGT. Behavioral competency integrity and awareness of limitations are both associated with advantageous decision-making profiles.

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1. Introduction

Decision-making is a broad and complex construct used in several domains, such as finances and health management. In the neurobehavioral sciences, decision-making is defined as the ability to make choices advantageous for survival in the long term [1]. Data from the literature indicate that this concept covers a complex set of cognitive and emotional processes related to the ability to modulate the perception of reward and punishment to arrive at choices advantageous in the long term [2–4]. In an experimental setting, decision-making can be assessed by gambling tasks, thought to simulate real-world decision-making. These tasks require that participants make the most advantageous decisions by choosing options that provide the best reinforcement from among several alternatives, and are based on either reinforced learning, where premises, outcomes, rewards and punishments are initially unknown (decision under ambiguity) [1], or on situations where the potential consequences of different options and their subsequent probabilities require explicit information (decision under risk) [2,3]. In both types of task, the best option is that which provides the lowest, but safest, reward.

Thus, decision-making tasks that depend on reinforced learning set risk-taking against benefits to operationalize decision-making as ''making choices advantageous for survival in the long term''. The expected behavior mediated by reinforcement is to choose the safest options and, thus, the lowest benefits (see the Iowa Gambling Task below).

Decision-making has been modelled according to a process involving three main steps [5,6]. The first uses the stimulus-encoding system, involving the ventromedial prefrontal cortex (VMPFC), striatum and orbitofrontal cortex (OFC). This step identifies the different options and attributes an expected value to each of them. The second step concerns the action-selection system, which is involved in learning and subjective value encoding. In this step, the subject gives preference to an option and selects an action, and the decision seems to be processed mainly in the anterior cingulate cortex (ACC), lateral prefrontal cortex, and lateral and medial intraparietal cortices. The third and final step uses the expected-reward system, involving the amygdala and basal ganglia in particular, thought to be modulated by the dopaminergic system. In this step, a comparison is made between the expected value and the one obtained, with the appearance of feelings such as regret or disappointment.

Other conceptualizations in experimental settings using reinforced learning and benefit/cost ratios have also been devised. These studies, which require participants to perform a physical task (effort) in return for real benefits, have reported interesting results on the brain areas involved in costs (dorsal ACC), benefits and subjective values (VMPFC), and their relationships [7,8]. In a similar way, other studies have reported noteworthy results on the neural areas and mechanisms involved in reinforced learning and which influence choices [9].

Yet, in spite of their relevance, these experimental designs appear more appropriate for approaching motivation, willingness, representations of reward value and preferences for a specific option, which mostly relate to the first step in decision-making (how the brain learns implicitly to choose the option that minimizes the cost of action) [8]. However, decision-making in terms of adaptation for survival [1] involves the ability to modulate the perception of reward and punishment to distinguish the greatest reward from the safest option, then operating according to the best choice in the long run. The present report focuses only on this second process.

Through laboratory decision-making tasks, neuropsychological research has significantly improved our knowledge of the fundamental mechanisms of decision-making as well as the factors that may diminish the ability to make advantageous decisions [10,11]. Yet, despite the extensive use of laboratory decision-making tasks in research and, more recently, in clinical practice, evidence of their ecological validity is still lacking. Nevertheless, arguments in favor of the ecological validity of tasks dedicated to assessing real-world decision-making in a laboratory setting are required for interpretation [12]. Ecological validity refers to the similarity between a behavior observed in an experimental setting and that observed in natural conditions. This suggests that decision-making processes are involved in the complex activities of daily living (ADL), and require an awareness of the limitations in these complex activities (for instance, the ability to be efficient and careful).

Alzheimer's disease (AD) and mild cognitive impairment (MCI) are both characterized by functional impairment of complex activities that involve decision-making processes (financial management, appointment scheduling, taking complex drug treatments) [13–15]. In addition, in patients with the two clinical conditions, various studies have also documented impaired awareness of limitations [16,17]. Furthermore, these patients typically perform less well than do healthy controls (HC) in decision-making tasks: they make random decisions and show poor strategic stability because of their difficulties learning from feedback [18–22]. A recent study suggested they were unable to remember previously learned responses or to establish new stimulus–reward relationships. This profile as been shown to be congruent with the temporal and parietal atrophy reported in the pathology [22]. Also, it was recently found that the decision-making profile in MCI patients mimicks that of AD patients [23]. However, to the best of our knowledge, no study has investigated the association between decision-making and everyday behavioral competency in MCI and AD patients compared with HC.

Using these same three groups of participants, the aims of the present study were to assess an ecologically relevant decision-making task by:

- comparing MCI and AD patients' abilities to perform a variety of everyday tasks;
- exploring the contribution of behavioral competency to decision-making performances;
- and exploring the contribution of awareness of limitations of behavioral competency to decision-making. This is our original contribution to the literature, as these associations

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