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The Digitalized Assessment for Decision-Making (DAsDec): a novel integrated neuroscientific and behavioral tool

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ABSTRACT

Decision-making processes involve a dynamic interplay between cognitive and emotional mechanisms. While traditional models address these components, few tools assess decision-making in an ecological, multi-dimensional way: the Digitalized Assessment for Decision-Making (DAsDec) tool was developed to meet this need. DAsDec evaluates decision-making skills across five key domains: decision style, strategies, effectiveness, awareness, and metacognition. Its modular structure allows for flexible administration and is adaptable to various contexts, including educational, organizational, legal, and sports fields. The tool integrates behavioral, psychophysiological, and neurocognitive measurements, such as autonomic indices and wearable electroencephalogram (EEG) application, providing a comprehensive analysis of decision-making abilities. DAsDec offers unique insights by combining self-assessment, realistic simulations, and objective neurocognitive data, allowing for a thorough evaluation of the multicomponential facets of decision process. Ultimately, this commentary discusses how this tool holds great potential for enhancing decision-making skills across a range of applied contexts.

Keywords: decision-making; neuroassessment; applied neuroscience; behavioral; EEG

1. A NEW NEUROTOOL FOR ASSESSING THE DECISION-MAKING PROCESS

All the decisions we make are based on the expectations we have about the outcomes that may result from that decision. The role of emotions and cognition in decision-making processes has been widely discussed in the psychological and neuroscientific literature, however, to date there is a lack of tools that allow us to evaluate the multifaceted nature of this process in an ecological way.

The most recent neuroscientific models in decision-making take into account the dichotomy between implicit and explicit processes in decision-making (Rilling & Sanfey, 2011); however, they lack a comprehensive reference framework that considers the different and multiple components of the decision-making process, such as decision styles and strategies, effectiveness, awareness, and decision-making metacognition.

Moreover, the neuroscientific literature provides various cognitive and psychological tasks to measure the decision-making process, such as the popular Iowa Gambling Task (Bechara et al., 2005) widely adopted in clinical samples over the lifespan (Gomes Da Mata et al., 2011; Mullaly et al., 2007), or the Ultimatum Game, which has been applied in the organizational contexts (Butler, 2017), to evaluate specific categories of decision-making, such as the financial (Frydman & Camerer, 2016) or moral one (Balconi, Angioletti, & Fronda, 2023) in top managers. Nonetheless, a complete tool for assessing the different dimensions of decision-making abilities to be used even in healthy samples is still lacking.

To meet the need for tools capable of measuring the multicomponential nature of the decision-making process, a new neuroscientific tool was recently created to assess decision-making skills and processes in organizations, called DAsDec (Digitalized Assessment for Decision-Making) (Balconi, 2023).

DAsDec is characterized by a modular structure with five distinct domains that operate independently, thus providing a focused view of the evaluated subject's skills and abilities. These five domains are closely interconnected, following a hierarchy of related decision-making competencies, thus ensuring a systematic and in-depth representation of the decision-making process.

It is a digitalized tool administered through a web-based platform, designed for easy administration and access. Its modular structure, composed of five distinct domains, allows for flexible administration adaptable to the needs and context of the assessment. The generated report offers various levels of analysis, customizable according to the specific needs of the context and the individual. This tool provides a comprehensive assessment when all five domains are administered, but also offers the possibility of assessing each domain individually to focus on specific aspects of decision-making skills.

Each domain offers an independent assessment through scores and profiling indices of the individual's performance, allowing for both quantitative and qualitative measurement of the subjective response. Moreover, DAsDec stands out as a multi-methodological tool, as it incorporates a variety of assessment tools: within the various domains, there are self-assessment measures, realistic simulations of decision-making scripts, as well as cognitive tasks and neurocognitive measurements.

To further enrich the analysis, behavioral measurements are integrated with psychophysiological metrics through biofeedback to detect autonomic activation, and neurocognitive measurements using non-invasive electroencephalography through wearable systems. The inclusion of these metrics provides a wide range of evaluation indicators based on physiological markers, contributing to a comprehensive and in-depth assessment.

Each domain is also composed of a series of Factors, which define and identify the specific functions of the domain itself. Each factor includes specific Components that characterize individual aspects of the Factor, which are investigated and tested through the tasks and measures that constitute the tool (Figure 1).

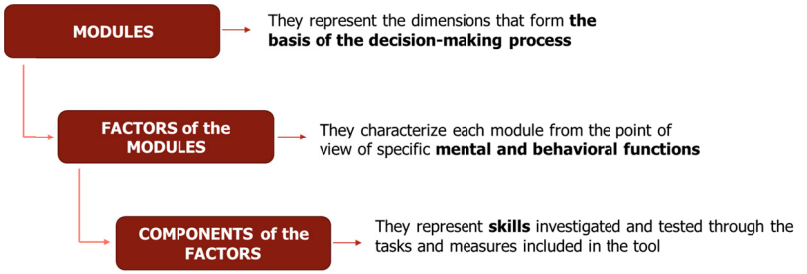

Figure 1. Structure of the DasDec tool conceptualized in modules, components, and factors organization

As previously mentioned, the tool is characterized by a modular and hierarchical structure, organized into five distinct and independent domains:

i. Mod1STY – Decision Style: it aims to outline personal attitudes and dispositions that manifest as stable characteristics of the individual, independent of the specific decision-making context, as they are more associated with the individual's personal decision-making style

ii. Mod2STR – Decision Strategies: it explores the ability to adaptively analyze the context in order to design, plan, and implement a functional decision-making process in response to the context
iii. Mod3EFF – Decision Effectiveness: focuses on the decision-maker's ability to use available resources (information, time, internal/external resources, context) to ensure efficient and effective decision-making
iv. Mod4AWA – Decision Awareness: it refers to the ability to develop full awareness of one's own thinking strategies, intentional planning, and action in complex decision-making tasks
v. Mod5META – Decision Metacognition: it aims to outline cognitive and metacognitive skills for self and contextual representations in the decision-making process, in hypercomplex decision-making tasks that also require the functional use of executive functions (Figure 2).

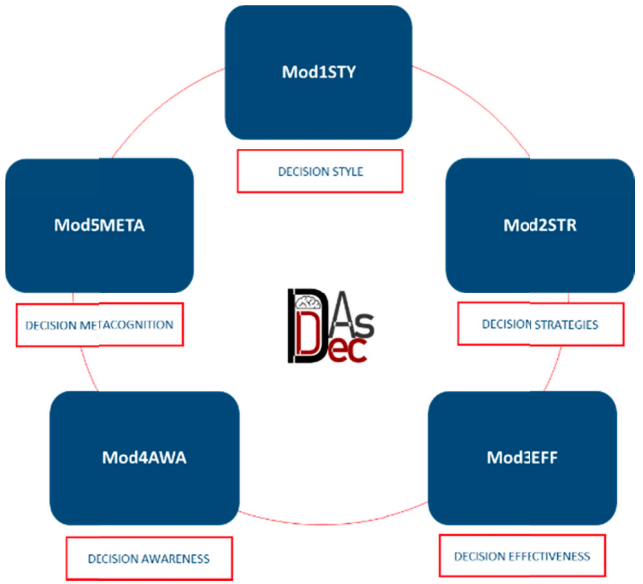

Figure 2. Graphical representation of the five modules constituting the Digitalized Assessment tool for Decision-Making (DAsDec) tool

For each of these modules, factors and components, some experimental evidence has been provided in the literature.

Module 1 (Mod1STY) that evaluates the decision-making style, includes tasks and measures that assess the following four factors: the self-evidence of one's decision-making objectives (Balconi, Angioletti, et al., 2023), the degree

of adaptability (Rovelli et al., 2024), the ability to take on and manage risk situations (Crivelli, Allegretta, et al., 2024), the regulation of stress synchronously and diachronically (Balconi, Angioletti, & Rovelli, 2024).

Module 2 (Mod2STR) which assess decision strategy, related to the ability to make decisions considering the role and significance of the context: conceptualized as the degree of independence from the context (Crivelli, Acconito, et al., 2024b), the ability to recognize and contrast biases (perceptual, attentional and conceptual) (Acconito et al., 2024a; Balconi, Acconito, Rovelli, & Angioletti, 2023); to develop appropriate reframing strategies (Angioletti et al., 2024); to evaluate the external and internal feedback to the system (Crivelli et al., 2023).

Module 3 (Mod3EFF) assesses decision-making effectiveness, expressed in a series of skills such as: the ability to decide according to an evidence-based perspective; to plan and act according to both an analytical and synthetic level; to adjust one's decision in terms of time and according to an economy of scale; to procrastinate and delegate one's decision; to use the resources of the group to reach the most functional decision (Acconito et al., 2024b).

Module 4 (Mod4AWA) evaluates the decision-making awareness that is played out in terms of: ability to identify one's limits and potential as a decision maker; to formulate thoughts and plans of action in full awareness; to make use of rewards as reward-related decisions and reward-responsivity (Balconi, Acconito, & Angioletti, 2024); to evaluate the strategies and decision-making styles of others.

Module 5 (Mod5META) measures decision-making metacognition, which is based on the ability to plan short- and long-term decisional plans in complete autonomy and awareness; the tolerance to the degree of decision complexity; the ability to resort from time to time to mechanisms regulated in self-awareness or automatism, in relation to the context (Balconi, Acconito, Allegretta, et al., 2024); the self-regulation of attention (Balconi, Acconito, Allegretta, & Crivelli, 2023); the intrinsic control of the emotional components that act "inside" a decision (Crivelli, Acconito, et al., 2024a); to evaluate the impact and moral significance of their decisions.

Overall, DAsDec aims to provide a comprehensive assessment of decision-making skills in an ecological way in several contexts. Its modular and multi-methodological structure integrates different evaluation tools (behavioral, psychophysiological, and neurocognitive measurements), enriching the analysis of decision-making processes and providing a thorough and complete view of the factors influencing decisions.

Evaluating decision-making skills is particularly relevant for several applied contexts, including business, healthcare, and education. In business, effective decision-making can lead to successful strategies and improved outcomes, while poor decisions may result in financial loss or missed opportunities. In healthcare, professionals must make critical decisions quickly, often under pressure,

impacting patient safety and treatment effectiveness. In education, teachers and administrators rely on sound decision-making to enhance student learning experiences and address diverse challenges. Understanding how individuals and groups make decisions is crucial for optimizing processes, mitigating risks, and fostering innovation across these domains.

2. Practical examples of DAsDec's application contexts

The flexible and modular nature of DAsDec and the scripts, tests and tasks included in the battery allow a high level of applicability of the tool to various contexts, from the educational, organizational, medical, sports and all contexts in which it is intended to evaluate the decision-making process as a multicomponential construct.

At present, DAsDec has been applied in the educational context on a large sample of healthy young adults. These data, in addition to providing an overview of the decision-making process of a young adult (e.g., a university student) are useful for at least two other reasons: the first is that these data can be useful to give the student himself an overview of the strengths and weaknesses that he shows in making everyday decisions, which are also connected to his future professional path; the second is that these data can serve as basic research data relating to a healthy control group, without particular distinctive characteristics in terms of decision-making derived from the professional influences.

Considering the professional influences, DAsDec has also been applied to the organizational context with different objectives such as providing professionals with feedback on their decision-making styles in terms of awareness of how they set their daily job goals (Balconi, Angioletti, et al., 2023), or determining any decision-making strategies that distinguish senior managers with greater expertise from junior managers with less professional expertise (Angioletti et al., 2024). Indeed, in the organizational contexts, the decision-making process involves and concerns every different level and sector of an organization, from the individual employee (of any professional rank), who must face ordinary decisions related to managing their daily work commitments and objectives, to the broader system, where organization members as a group should decide on policies, strategic action plans, and significant management changes that can affect the entire company. Having adequate decision-making skills in a company allows an individual to feel that self-confidence – typically possessed by professionals who know they have the right tools to make a decision – that enables them to make the best choice with

a low probability of error. This means being able to choose the most effective and efficient solution for the organization, which can have a significant impact on its performance and consequently on its competitiveness.

Furthermore, another interesting context in which DAsDec has been applied is the legal one. The tool has been applied to samples of lawyers to determine their decision-making profile. In fact, in the legal context, the decision-making process plays a crucial role because lawyers are often faced with complex situations where they must weigh multiple factors, such as legal precedents, ethical considerations, and client interests. Moreover, previous works demonstrated the added value of integrating behavioral with neurophysiological data in the evaluation of lawyers' decision-making (Angioletti et al., 2022, 2023; Balconi, Greco, Rovelli, et al., 2024). A thorough decision-making assessment helps to evaluate how well legal professionals navigate these challenges, manage risks, and arrive at sound judgments. This becomes particularly important in high-stakes cases, where the outcome can have significant implications for justice, client well-being, and legal integrity. By using tools like DAsDec, law firms and legal institutions can foster more strategic and balanced decision-making, ensuring better results in litigation, negotiation, and advisory roles.

Other application areas explored to date include the sports field. The assessment of decision-making processes with DAsDec has been applied to a sample of sport referees, which constitutes an interesting population because referees are required to make quick, accurate decisions under high pressure, often in real-time, with minimal opportunity for reflection. Their decisions can directly influence the outcome of games, making their ability to remain impartial, focused, and composed essential. A previous work proposed a threshold process model for decision making in sport games based on behavioral data (Raab et al., 2021). However, analyzing their decision-making profiles by integrating behavioral and neurophysiological data may provide highly informative insights into how stress, crowd influence, and fast-paced dynamics affect the decision process and the final judgment. Understanding these factors can lead to improved training programs aimed at enhancing performance and consistency in officiating.

As neuroassessment tool, DAsDec could also be applied to athletes in the future, as they too face situations where rapid decision-making is crucial, particularly during competitive events. Athletes must evaluate multiple variables, such as strategy, opponent behavior, and physical conditions, all while managing their emotions and fatigue (Crivelli & Balconi, 2022). Applying DAsDec in this context could help coaches and sports psychologists identify areas where athletes can improve their cognitive flexibility, risk assessment, and reaction time, potentially giving them a competitive edge.

These are just some of the examples of application of the tool, however, it could be applied to a wide range of other fields. For instance, in the corporate sector, it could be used to assess the decision-making skills of managers and executives, helping organizations identify leadership strengths and areas for development. In the public sector, it could assist policymakers in evaluating how they approach complex societal issues and make data-driven decisions that in turn can impact communities. The tool could also be valuable in the field of emergency services, where first responders must make split-second decisions in life-threatening situations and the decision-making assessment could provide an overview of strength and vulnerabilities of the responder. In all these contexts, DAsDec could provide valuable insights into decision-making patterns, ultimately improving outcomes across various industries and contexts.

3. Conclusions

In conclusion, decision-making processes involve a complex interaction between rational components, emotional dynamics, and subjective interpretations. Both explicit cognitive strategies and implicit emotional responses are critical in shaping decisional outcomes. Tools like DAsDec play a crucial role in this context by providing a comprehensive evaluation of decision-making abilities through its innovative modular structure.

DAsDec offers unique value by assessing five distinct domains - decision style, strategies, effectiveness, awareness, and metacognition - each contributing to a deep understanding of an individual's cognitive and emotional functioning during the process of decision. Its integration of behavioral, psychophysiological, and neurocognitive measurements, such as autonomic indices and electroencephalogram, allows for a multi-faceted analysis of decision-making processes.

Furthermore, the tool's capacity to measure implicit emotional responses alongside explicit cognitive strategies ensures a holistic view of how decisions are made under pressure. By providing detailed profiles and real-time feedback on decision-making tendencies and biases, DAsDec empowers individuals to improve decision effectiveness, reduce errors, and enhance overall performance. This not only boosts individual and group outcomes but also contributes to the well-being of individuals by fostering greater self-awareness, confidence, and emotional regulation in complex decision-making scenarios. Ultimately, DAsDec is invaluable for refining decision-making skills in several distinct applied contexts, such as, by way of example, the educational, work organizations, legal and medical context, and the sports-field.

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