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Assessing decision-making skills: preliminary proof-of-concept data for DAssDec - Mod_{1STY} and Mod_{2STR}

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ABSTRACT

From a psychological and neuroscientific perspectives, decision-making can be defined as a skill, a function and/or a process we pervasively implement in our everyday life. Embracing a definition of decision-making that describes it as a multicomponential, pervasive, and instrumental ability, the Digitalized Assessment Tool for Decision-Making (DAssDec) – a novel digitalized assessment tool – has been devised with the specific purpose to capture the multifaceted nature of decision-making and to sketch an articulated profile of its many dispositional and situational manifestations. We here introduce preliminary outcomes from proof-of concept and feasibility study performed on the first two domains of the DAssDec Tool – Mod_{1STY} and Mod_{2STR} – dedicated to decisional styles and strategies. 35 professionals working in managerial departments of a large service company took part in the study. Findings pointed out the feasibility, usability, and practical value of the investigated sections of the DAssDec tool. Also, first quali-quantitative analyses of participants responses and performance at the tasks included in the tested domains have already highlighted the potential of the tool to detect inter-individual differences, thus pairing the opportunity to outline a global profile of a work team with specific individual profiles of decision-making skills and their subjective determinants.

Keywords: decision-making; assessment; digitalized tool; higher cognition

1. The Digitalized Assessment Tool for Decision-Making – DAssDec: presentation of Mod_{1STY} and Mod_{2STR}

Following previous contributions included in this Special Issue, we here briefly introduce preliminary outcomes from proof-of concept and feasibility study performed on the first two domains of the Digitalized Assessment Tool for Decision-Making – DAssDec. The tool – devised with the specific purpose to capture the multifaceted nature of decision-making and to sketch an articulated profile of its many dispositional and situational manifestations – includes five independent (though linked) domains that explores five core pillars supporting the actual implementation of decisional processes in real life situations: Decisional Styles (Mod_{1STY}), Decisional Strategies (Mod_{2STR}), Decisional Efficacy (Mod_{3EFF}), Decisional Awareness (Mod_{4AWA}), and Decisional Metacognition (Mod_{5META}). Given the current focus on the first two domains, we will start by adding more details on the internal structure of Mod_{1STY} and Mod_{2STR}.

1.1 Domain one - Mod_{1STY}: Decisional Styles

Mod_{1STY} investigates four main constructs via four dedicated tasks/tests: (i) representation of decisional objectives; (ii) adaptivity to change; (iii) risk taking and management; and (iv) stress regulation/tolerance.

In the first task, the ability to represent decision-making objectives is quantified based on individual performance when asked to freely create a list of tasks/activities involving decision-making that the examinee faces in a typical working day, and then to recall and reorder them based on fixed criteria: priority, temporal sequence, and quality of outcomes. When reordering by priority, the examinee must assign the first position to the most important task/activity and the last position to the least important task/activity. During the reordering by temporal sequence, the first position must be assigned to the task/activity carried out first in the day and the last position to the task/activity carried out last. Finally, in the reordering by outcome, the first position is represented by the task/activity with the best outcome and the last position by the one with the worst outcome. Both the free recollection step and the three reordering steps are to be completed within a fixed time. Performance metrics for this task – mirroring the number of freely recollected decisional tasks/activities and the number of tasks/activities actually reordered by priority, temporal sequence, and outcome – indicates the ability of the examinee to self-represent decision-making objectives and activities of the day and to contextualize them with respect to their relevance, timing, or quality of outcomes. Also, such metrics allow to highlight, if present, the implicit dominant key guiding self-representation of daily tasks and objectives in the

examinee – i.e., whether he/she is mainly guided by decision priority, timing, or outcomes when recalling his/her duties.

In the second task, the ability to flexibly respond to external variables that lead to change, to voluntarily produce a change, and to introduce innovative elements into decisions are explored by introducing the examinee to different real-life scenarios and asking them to choose between alternative actions. Even in this case, time of responding is used as a relevant performance metrics mirroring information processing effort. Based on response times and actual choices between alternative actions, flexibility, proactivity, and innovativeness scores are computed. Specifically, the flexibility score measures the ability to respond appropriately, effectively, and flexibly to external variables that cause unexpected changes influencing the decisional process. The proactivity score, on the other hand, mirrors the person's ability to intentionally introduce a change in order to improve a situation. Finally, the innovativeness score defines the ability to think out of the box and introduce new and creative elements into decisions.

In the third task, attitudes toward risk taking and towards management of risks implied by making decisions are explored by asking people to put themselves into specific decisional situation and choose between different alternatives connoted by different levels of risk. Actual responses and response times both contribute to the computation of risk taking and risk management scores. The risk taking score, specifically, measures the tendency to assume the risks associated with decision-making, while being aware of responsibility for related outcomes. The risk management score, instead, mirrors, besides assuming the risk associated with decisions, the ability to manage the consequences of such decisions and of the assumed risk over time and the awareness of the resources needed to face such risks and uncertainties even when they did not depend on the subject him/herself.

Finally, the fourth task explores stress regulation and tolerance skills by asking the examinee to get involved in an active stressing performance. Namely, the examinee is asked to prepare five speeches concerning specific topics under time pressure and then to give them under different conditions that gradually increase their stressful nature. Based on speech preparation times under those different conditions, a stress regulation score and a stress tolerance score are obtained. The stress regulation score mirrors the ability to manage stress in short periods of time and still produce and effective performance. The stress tolerance score indicates the personal ability to tolerate stress over time in progressively stressful situations.

1.2 Domain two - Mod_{2STR}: Decisional Strategies

Mod_{2STR} investigates four main constructs via four dedicated tasks/tests: (i) sensitivity to the context; (ii) control of biases; (iii) evaluation of alternatives and reframe; and (iv) evaluation of the feedback.

In the first task the level of information processing by decision makers in contextualized scenarios is explored by looking at their use of simple pieces of information, of broader patterns of situational cues, or of higher-level information linked to the features of the task to be completed. Specifically, the examinee as to face realistic decisional scenarios and opt for different ways to solve an emerging problem, in doing so he/she can rely on different information cues. Metrics deriving from this task allow to profile the examinee positioning with respect to information-oriented, situation-oriented, and task-oriented decision-making. The information-oriented decision-making score measures the ability to orient one's choices on the basis of simple low-level information. The situation-oriented decision-making score, on the other hand, mirrors the ability to make decisions based on the entire situation and its characteristics. Finally, the task-oriented decision-making score represents the ability to make decisions having in mind the higher scope of the task to be completed and reading contextual cues and constraints at the light of such objective.

In the second task, the ability to control biases that shape perception, attention, and behaviour (and thus to intentionally resist or even use them) is investigated via three dedicated subtasks.

In the perceptual biases subtask, the examinee is presented with a perceptual decision task where he/she has to determine whether or not there was an animal (target stimulus) in a briefly-presented complex visual stimulus composed by different pictures. The complex visual stimulus was preceded by a perceptually related or unrelated prime The attention biases subtask, on the other hand, is designed as a Posner spatial cueing task (Posner, 1980) and, specifically, as an exogenous spatial cueing task. Participants has to quickly signal whether a target stimulus appears at the left or at the right of a fixation cross. The occurring position of target can be correctly of wrongly cued. In the nudging subtask, nudges are used to try and manipulate behavioural choices of the examinee and investigate his/her ability to resist such behavioural shortcuts. The examinee is presented with nudged or non-nudged scenarios where he/she has to make behavioural decisions. The ability to counter such biases is measures as the number of non-nudged choices. From these three subtasks, three main metrics are obtained. Specifically, the perceptual bias control score measures the ability to quickly detect the correct answer within a set of distractors and is computed based on both accuracy index and response times. The attentional bias control score, on the other hand, indicates the ability to

direct the attentional focus in a functional way and inhibit the incorrect response. This score too is computed based on accuracy index and response time. Finally, the nudging control score measures the ability to resist external reinforcements suggesting predetermined behaviours and act intentionally. It is computed based on the examinee's choices.

In the third task, the ability to critically analyse and evaluate alternatives in situated decision-making processes and, if needed, to resist to cognitive biases affecting decision-making is measures via two subtasks. Specifically, the first subtask, aimed at testing the sensitivity to alternatives and to reframing during the evaluation of alternative choices, asks the examinee to make management decisions and then test the stability of his/her choices by providing a novel frame to such decisions. In the second subtask, the ability to resist to cognitive biases in realistic decisions is more specifically tested by asking the examinee to make a decision under different sequential situations where more information and alternatives are progressively added. From those subtasks, two main metrics related to the sensitivity toward alternatives and evaluation the alternatives are obtained. The sensitivity to alternatives score measures the sensitivity to the reformulation of a situation during the evaluation of the decision-making alternatives. The evaluation of alternatives score, on the other hand, mirrors the ability to actively oppose cognitive bias in making a decision by looking at difference in examinee's decisions when presented with two or more alternatives.

In the fourth task, the role of feedback evaluation in shaping and re-orienting the decision-making process is explored via a multistep decisional task. Paying attention to external feedbacks and using such information to adapt own choices or intentionally maintain the chosen path are crucial skills for situated decision-making, especially when it declines into complex contexts including other agents. The examinee is asked to choose between different alternative responses to realistic challenges and, after receiving positive or negative feedbacks on his/her choice, he/she has the opportunity to keep, partially remodulated or totally change the actions they choose. Metrics derived from this task measure the drive towards re-evaluating a choice based on external positive or negative feedback and depend on the degree of change introduced in chosen behaviour after receiving a reinforcing or an unpleasant comment on the own choice and its consequences.

2. DASSDEC MOD$_{1STY}$ AND MOD$_{2STR}$ PRELIMINARY TESTING: PROOF-OF-CONCEPT AND FEASIBILITY STUDY

2.1 Sample

The preliminary sample for the proof-of-concept and feasibility study included 35 professionals (female: 22; male: 13) working in managerial departments of a large service company. Participants' age ranged between 24 and 59 years (M_{age} = 38.29, SD_{age} = 9.53). All participants hold their job positions in the company since at least one years at the moment of data collection. Such inclusion criterion was introduced to try and prevent biases in collected data due to situational factors such as enhanced stress due to recent position changes or increased workload during adaptation to new job duties or responsibilities. Also, in order to increase the generalizability of first evidence and of notes on feasibility and usability of the tool, participants with different specializations (e.g., management of human resources, training and professional learning, engineering and maintenance management, monitoring of service quality, management of infrastructures, etc.) have been enrolled. In the reported preliminary testing of the tool, we focused on management professionals as a key target population for future implementations of the tool. Specifically, such population presents crucial work-related features – i.e., everyday confrontation with complex decision-making, commitment to optimal performance in changing (and often ambiguous) conditions, need for their decisional processes to adapt to real-life situations and their constraints – that makes them ideal subjects to critically test a tool that want to capture and profile real-life decisional skills in their multicomponentiality and practical implications. And again, tight agendas and remarkable workload that connote such population acted as a further test for practical feasibility and applicability of the digitalized tool as an assessment instrument in real-life professional contexts.

None of participants reported history of psychiatric or neurology disorders. None of them was undergoing a concurrent therapy based on psychoactive drugs that could alter cognitive or decisional skills. Also, none of them showed clinically relevant signs of distress or job-related burnout. All of participants had normal or corrected-to-normal vision.

The study and the assessment procedures has been designed following the principles of the Declaration of Helsinki. Individual informed written consent was obtained at the beginning of the study. Methods were approved by the Ethics Committee where the work was carried out.

2.2 Data collection and procedure

Data collection occurred between September 2022 and November 2022. Assessment session was conducted by certified psychologists with established experience in experimental research and/or psychodiagnostics. The tool was administered in one-to-one sessions, in a quiet dedicated room at participants' workplace. We opted for such setting in order to increase the ecological validity of data collection by preserving the everyday working context of the enrolled testing sample. Such opportunity has been made possible by the digitalized cross-platform nature of the tool and by the portability of supporting neuroscientific devices used to complement behavioural data with physiological ones during this initial testing of the tool. Going down to specifics, electrophysiological markers of workload, engagement, and attention focusing was collected via wearable EEG while participants enrolled for the proof-of-concept and feasibility study completed the implemented tasks of the tool. Concurrently, autonomic indices – i.e., electrodermal activity, as measured via skin conductance level and skin conductance response, and cardiovascular activity, as measured via heart rate and heart rate variability – were also collected while participants completed the implemented tasks in order to monitor and investigate task-related modulations of physiological arousal.

Relevant to this discussion, it is worth noting that the preliminary study here we report was focused on the first two domains of the digitalized tool. Besides being the first to be fully implemented, they were chosen for this preliminary step of testing since they were devised to investigate two core supporting pillars of decisional skills. Taking management professions as an exemplifying case, the possibility to sketch a profile of individual aptitudes toward self-representation of goals and decisions, adaptability of decisional processes, orientation towards risk taking and management, and regulation of stress under challenging conditions might represent a remarkable strategic advantage to improve job-person matching, thus plausibly increasing job satisfaction and personal wellbeing. Consistently, the ability of a professional to properly implement individual decisional skills into a specific real context by paying attention to the context and its cues, by controlling (and sometimes exploiting) cognitive biases, by flexibly evaluate alternatives and choose, and by taking into account external feedbacks is a crucial personal factor to be assessed in order to better sketch such decisional skills when they move from potency to act.

During the assessment sessions, participants were invited into a quiet room and asked to sit on a comfortable chair in front of a PC. The tasks constituting the first two domains of the DAssDec tool were administered via a web-based survey and experiment-management platform. Participants were then asked to wear non-invasive sensors for collection of central and peripheral

physiological activity at rest and during task execution. Namely, a wearable EEG system with dry sensors (Muse™ headband, InteraXon Inc., complemented with the MindMonitor app) was used to capture resting-state and task-related modulations of EEG spectral activity, as mirrored by changes of power for standard frequency bands (delta, theta, alpha, beta, gamma). Peripheral autonomic activity at rest and during exposure to assessment tasks was, instead, monitored and captured via a wearable multipurpose sensor collecting electrodermal and cardiovascular activity data (Biofeedback 2000^{xpert} system, Schuhfried GmbH) placed on the distal phalanx of the second finger of the non-dominant hand. Electrodermal activity was quantified as skin conductance level and response, while cardiovascular activity - measures via photopletismography – was quantified as heart rate and heart rate variability. Such physiological data was collected to complement and enrich observations based on participants behaviour and responses. Given the preliminary nature of this report, we will now focus the discussion on currently available behavioural data, leaving the integration and comparison of such level of analysis with the physiological one once data will be consolidated and the sample size will be increased.

2.3 Preliminary outcomes from the proof-of-concept study

Behavioural and performance data coming from the proof-of-concept and feasibility study on Mod_{1STY} and Mod_{2STR} of the DAssDec tool has been firstly scored and checked for their consistency and completeness. All participants of the preliminary testing sample completed all tasks and subtasks constituting Mod_{1STY} and Mod_{2STR}. None of participants showed or explicitly reported signs of frustration or excessive cognitive weariness during or immediately after the assessment sessions. No technical complaints were noted during the execution of the tasks and subtasks, suggesting a good usability and reliability of the administration platform and of the digitalized format of the implemented domains. During the post-assessment debriefing session, participants reported to the experimenters that the tasks they performed were sometimes challenging and that they often felt engaged in the realistic decision-making situations they had to face and respond to. On average, administration times for each of the two domains was around 30 minutes. Nonetheless, even taking into account field notes and final comments from the testing sample, it seems advisable to plan a pause between the administration of the domains if they are proposed in a single assessment session. That would better the experience of assessment as perceived by the examinee and prevent potential confounds due to progressive decisional fatigue.

Taking into account Mod_{1STY}, quali-quantitative analysis of data showed that, on average, professionals included in the preliminary testing sample were

able to evoke 3 to 4 main decisional tasks a day (M = 3.63, SD = 1.15). The fact that every participant was able to identify at least one main decisional activity when thinking at a typical working day and the variability of data (number of identified decisional tasks/activities: 5° percentile = 2, 95° percentile = 6) suggest that the task could effectively activate a recursive thinking in the examinee and grasp individual differences in self-representation and aware identification of task/activities relevant to the investigated construct. Notably, data analysis suggested that the most diffused implicit key used in the sample to self-represent own decisional tasks and activities is their outcome (number of decisional tasks/activities ordered by outcome: M = 3.34, SD = 0.92; number of decisional tasks/activities ordered by temporal sequence: M = 3.11, SD = 1.14; number of decisional tasks/activities ordered by priority: M = 2.86, SD = 0.99; see *Figure 1*). We suggest that such piece of information, hinting at the relevance for the tested sample of the consequences of a decision and decisional after-effects when asked to recall typical working duties, may provide valuable food-for-thoughts when using the tool to assess both single professionals and members of a work group. Indeed, besides profiling the self-representation of decisional styles, it might even become a topic for discussion with the examinee(s) in order to improve awareness of own mental schemata as they are implemented at the workplace.

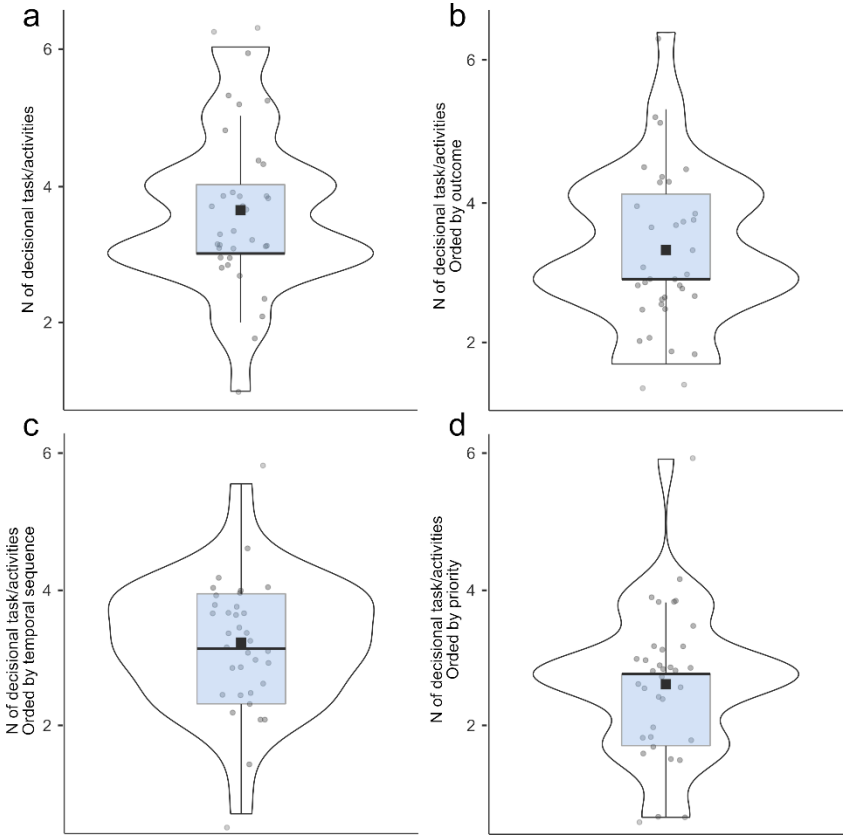

Figure 1. Violin plot of: (a) the total number of daily decisional tasks/activities, (b) number of decisional tasks/activities reordered by outcome, (c) number of decisional tasks/activities reordered by temporal sequence, (d) number of decisional tasks/activities reordered by priority. Boxes indicate the interquartile ranges. Means are indicated by the black squares

Again, data from the second task highlighted that the most occurring skill in the tested group when facing change and when asked to make decisions involving adaptability to information and contextual changes is proactivity (Proactivity score: M = 3.43, SD = 0.57; Flexibility score: M = 3.09, SD = 0.45; Innovativity score: M = 2.86, SD = 0.68; see *Figure 2*). This suggests the

presence of a dominant orientation towards authorship in decisions and towards the intent to actively introduce changes in order to improve situations that has to be faced over creative decision-making and reactive flexible decisional processes.

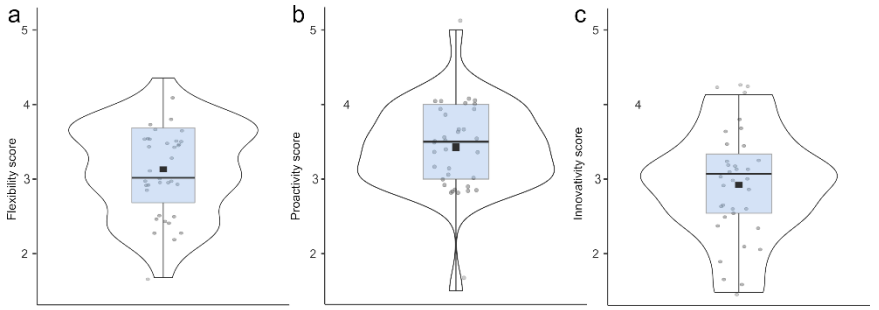

Figure 2. Violin plot of: (a) flexibility score, (b) proactivity score, (c) innovativity score. Boxes indicate the interquartile ranges. Means are indicated by the black squares

As for the third task, the sample showed greater risk management than risk-taking orientation (risk management score: M = 3.78, SD = 0.58; risk taking score: M = 2.41, SD = 0.74). This emerging profile might mirror a primarily cautious decisional style when facing risky situations, plausibly associated to the participants' professional life, paired with greater proficiency in managing the consequences of risky decisions over time and in being aware of necessary resources to face such consequences.

Finally, the analysis of responses at the fourth task highlighted generally good ability to regulate stress when exposed to transient stressors and involved in arousing tasks (stress regulation score: M = 4.59, SD = 0.37). Participants profiles become more variable when focusing on stress tolerance (stress tolerance score: M = 2.80; SD = 1.39). This latter observation suggest that the task is able to point out individual differences concerning the intrinsic ability to tolerate stress over time in progressively stressful situations. We suggest that this additional level of specification could help an assessor in increasing the finesse of job-person matching analysis.

Moving to quali-quantitative analysis of Mod_{2STR} data, the potential of the tool as a mean to point out individual differences and help profiling of decision-making skills seem confirmed.

Indeed, analysis of participants responses to the first task indicate a clear

preference for processing of broader patterns of information concerning the entire situation and its characteristics – more than low-level pieces of information or higher-level interpretation of contextual cues at the light of the higher scope of the task to be completed – when participants had to face realistic decisional scenarios and solve an emerging problem (situation-oriented decision-making score: M = 3.67, SD = 0.71; information-oriented decision-making score: M = 2.64, SD = 0.77; task-oriented decision-making score: M = 2.58, SD = 0.61; see *Figure 3*).

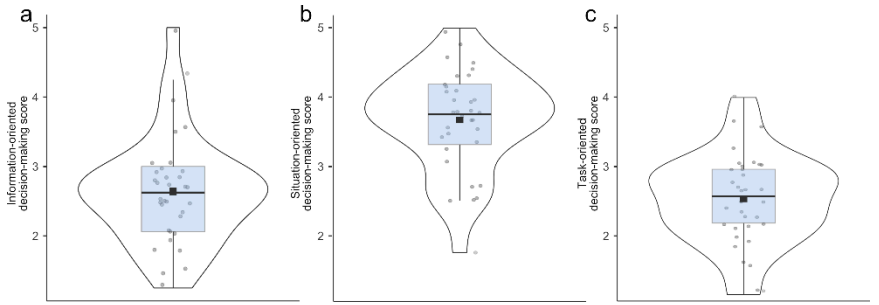

Figure 3. Violin plot of: (a) information-oriented decision-making score, (b) situation-oriented decision-making score, (c) task-oriented decision-making score. Boxes indicate the interquartile ranges. Means are indicated by the black squares

Similarly, performance data coming from the three subtasks of the second task – which is focused on the ability to control biases influencing perception, attention, and behaviour – proved to be sensitive to individual differences. Accuracy and, especially, response times (RT) at the perceptual decision-making, spatial cueing, and nudging subtasks presented remarkable variability. The perceptual biases subtask seemed to be the most challenging one, showing lower mean accuracy (M = 0.23, SD = 0.10) and highly variable RT (M = 926.80, SD = 251.08, 5° percentile = 643.37, 95° percentile = 1312.30). The attention biases subtask showed more consistent and higher accuracy scores (M = 0.98, SD = 0.01), but still variable RT (M = 416.64, SD = 51.54, 5° percentile = 365.98, 95° percentile = 494.63). Then, the nudging subtask showed slightly more variable responses in the sample (number of choices contrasting the nudge in nudged situations: M = 1.00, SD = 0.64) paired with highly variable RT (M = 8.89, SD = 3.12, 5° percentile = 6.07, 95° percentile = 14.55). Taken together, available data suggest that a focus on response times as a proxy for information-processing and decisional workload could be more useful than a focus on actual response or performance due to their observed

greater sensitivity to inter-individual differences.

The third task of Mod_{2STR} explored the ability to critically analyse and evaluate alternatives in situated decision-making processes and, if needed, to resist to cognitive biases affecting decision-making. Management professionals included in the preliminary testing sample showed high performance at the subtask tapping on the sensitivity to alternatives and to reframing during the evaluation of alternative choices (sensitivity to alternatives score: M = 4.82, SD = 0.71), and at the subtask tapping on the ability to resist to cognitive biases in realistic decisions connoted by progressively increasing alternatives (evaluation of alternatives score: M = 2.15, SD = 0.88). Such performance might mirror the experience of participants in facing decisions connoted by multiple potential frames of interpretations and by progressively added alternative possibilities of action. Whereas potentially interesting, we acknowledge that such interpretation is, with currently available data, still tentative and need to be properly and additionally tested.

As for the final fourth task, data analysis suggests a comparable effect for positive and negative feedbacks in shaping and re-orienting the decision-making process of enrolled participants (positive feedback score: M = 4.15, SD = 0.91; negative feedback score: M = 4.18, SD = 0.89). Such qualitative observation hints at the general power of contextual and social feedbacks as effective drivers towards keeping or re-evaluating a choice, besides being a strong promoter of behavioural changes. Nonetheless, the opportunity provided by this task to profile subjective sensitivity to both positive and negative feedback also represents a valuable advantage in the quest for identifying the motivational drivers of the examined individual, up to working for increasing his/her awareness of subjective processing of reinforcing and punishing rewards.

3. Conclusions

Following the introduction of a novel tool for the assessment of decision-making skills, we have here presented a proof-of-concept and feasibility study focused on its first domains and briefly summarized preliminary data from such testing on a sample of management professionals.

First available data pointed out the feasibility, usability, and practical value of the investigated sections of the DAssDec tool – i.e., domain one assessing Decisional Styles and domain two assessing Decisional Strategies. Also, first quali-quantitative analyses of participants responses and performance at the tasks included in the tested domains have already highlighted the potential of the tool to detect inter-individual differences, thus pairing the

opportunity to outline a global profile of a work team with specific individual profiles of decision-making skills and their subjective determinants.

Such opportunity, as well as the possibility to compare individual performances and responses at different tasks and domains, will be further strengthened in the final version of the DAssDec tool by using a common metric to express the calculation of each specific performance and response indicators for each cognitive domain.

Furthermore, the digitalization of the tasks constituting the tool seemed to pass the first feasibility and usability testing. No relevant remarks or difficulty in using the web-based data collection platform and the implemented tasks was noted by the experimenter or reported by participants, thus suggesting that the present version of the tool, though improvable, is ready for larger-scale implementation.

To conclude, preliminary testing of first two domains of the DAssDec tool hints at their informativity and robustness as a mean to investigate decisional processes and skills via realistic tasks, dedicated tests, and ad hoc decisional scenarios, in line with a multi-componential approach to assessment in realistic contexts (Balconi et al., 2019, 2020, 2022; Balconi & Crivelli, 2021; Crivelli & Balconi, 2022). While further testing and extended validation is needed to complete the evaluation of the tool, it seems a firs potentially valuable answer to the need for general assessment tools exploring actuated decision-making, thus complementing the limited alternative instruments that mainly focusses on self-report evaluation of own decisional skills.

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