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Working memory, Awareness of Choice (AoC) and Awareness of Action (AoA) in the decision-making process in a professional frame

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ABSTRACT

Working memory significantly influences decision-making effectiveness and decision-making awareness encompasses Awareness of Choice (AoC) and Awareness of Action (AoA). Additionally, internal (i.e., personality traits, expertise) and external factors (i.e., time pressure, incentives) influence the quality of decision-making. This study investigated behavioural correlates of two professionals' groups performing a novel dual task to explore AoC and AoA accuracy (ACC). 117 healthy individuals, divided into next-generation (N=75) and experienced professionals (N=42), completed the task, followed by the 10-item Big Five Inventory and Maximisation Scale. Findings indicate that experienced professionals have lower ACC than next-generation and that AoC turns out to be more difficult and cognitively demanding compared to AoA, maybe because thought processes are abstract and difficult to monitor and control. The lower awareness in experienced professionals, instead, could be attributed to work experience and work environment itself, that required to make complex, intuitive, and rapid decisions. Moreover, personality traits correlate differently with ACC in next-generation and experienced professionals, highlighting different personality patterns.

Keywords: working memory; awareness; decision-making; professionals

1. Introduction

Working memory and decision-making are interrelated cognitive processes that significantly influence daily and professional life.

Working memory, as defined by Baddeley, is a functional system responsible for the temporary storage and manipulation of information, which is crucial for various functions such as planning, inhibition, and cognitive flexibility (Baddeley, 1992; Hartley & Hitch, 2022). This system is a key component of executive functions, and tasks requiring inhibition and cognitive flexibility often also engage working memory resources (Ávila et al., 2015; Bruijn et al., 2018).

Decision-making, on the other hand, involves selecting among various options based on evaluation criteria and personal preferences, a process that is inherently complex and influenced by cognitive load (Crivelli et al., 2024b; Crivelli & Balconi, 2017; Rovelli et al., 2023). Additionally, this ability enables individuals to adapt strategically to situational changes, inhibits automatic reactions and impulses, allows for the manipulation and retrieval of information from memory, and promotes flexible responses to shifts in the environment, accurately identifying the goals to be accomplished (Balconi et al., 2023; Crivelli et al., 2023).

According to the literature, the functioning of working memory plays a pivotal role in the effectiveness of decision-making. In other words, the interplay between working memory and decision-making is crucial. Indeed, Kahneman and Tversky's studies on decision-making highlighted the influence of cognitive biases and heuristics, which can result in suboptimal choices when working memory is overwhelmed or when executive functions are impaired (Kahneman, 2011; Tversky & Kahneman, 1974). Moreover, also in the organizational setting, Laureiro-Martinez and colleagues evidenced how working memory represents one of the most crucial functions for adequate performance execution (Laureiro-Martinez et al., 2019). Such a complex and dynamic environment as the organizational one, in fact, requires that the cognitive functions of individuals be continuously engaged in gathering information, evaluating feedback, testing, reviewing knowledge, and executing selection possibilities (Balconi et al., 2024). Only through these skills, which are closely related to working memory, is it possible to make effective decisions, and improve work organization and management (Samson & Bhanugopan, 2022).

More specifically, following this perspective, individuals with higher working memory capacity are often better at considering multiple perspectives and potential outcomes, leading to more effective interactions and decisions (Ishiguro et al., 2024). This underscores the importance of fostering working memory skills not only for personal decision-making but also for enhancing interpersonal relationships and collaboration in professional settings.

Conversely, effective working memory can enhance decision-making by allowing for better evaluation and manipulation of information, leading to more informed and optimal choices. The ability to evaluate options critically and make informed decisions is closely tied to the efficiency of working memory, as it allows individuals to hold relevant information in mind while weighing different alternatives (McCabe et al., 2010).

On the other hand, when working memory is taxed or impaired, it can lead to poor decision-making due to increased cognitive biases and the use of heuristics (Balconi et al., 2024; Rovelli & Allegretta, 2023).

However, it is important to point out that even with a robust working memory, individuals can make poor decisions. One possible explanation for this is closely related to the concept of decision-making awareness. Indeed, decision-making awareness, which encompasses both choice awareness and action awareness, plays a pivotal role in the quality of decisions made and the perceived self-efficacy of the decision-maker (Alloway & Alloway, 2010).

Specifically, Awareness of Choice (AoC) is a multifaceted concept that encompasses the understanding of the implications and consequences of decisions made by individuals. This awareness is crucial for effective decision-making, as it requires critical reflection on both immediate and long-term outcomes (de Lange et al., 2011; Karni & Vierø, 2017). Closely related to the ability to reflect on immediate and long-term outcomes is the theory of "time perspective" (Boyd & Zimbardo, 2006; Zimbardo & Boyd, 2015). According to this perspective, individuals have an unconscious cognitive framework humans develop to interpret life experiences based on their orientation toward the past, present, or future (Holman & Zimbardo, 2009).

However, in addition to working memory, abstract thinking is a crucial cognitive function that affects the AoC and is necessary for good decision-making processes. Indeed, previous research indicates that abstract thinking enables individuals to generalize knowledge and apply it to novel and complex situations (Kocher & Sutter, 2006). In organizational settings, this cognitive flexibility is particularly relevant for senior managers who are tasked with making strategic decisions that have far-reaching implications. Moreover, the ability to consider multiple variables and complex interactions allows for a more comprehensive understanding of the potential outcomes of decisions, thereby enhancing the quality of choices made (Laureiro-Martínez & Brusoni, 2018; Sharfman & Dean Jr, 1997).

To summarize, considering its multicomponent nature and in light of the above, AoC can be defined as a construct that refers to the understanding of the implications and consequences of the decisions made, ensuring that individuals are mindful of the potential outcomes of their choices. This awareness is supported by reflective thinking, episodic autobiographical memory, abstract thinking, and a

sense of agency, all of which contribute to effective decision-making.

In contrast, Awareness of Action (AoA) pertains to the recognition of oneself as the author and regulator of one's decisions. This awareness is closely linked to the concept of agency, which Bandura defines as the perception of being the agent of one's actions (Andreou, 2013; Bandura, 2006; Haggard & Eitam, 2015). The theory of self-efficacy further elucidates this relationship, suggesting that the belief in one's ability to perform specific actions significantly influences motivation and behaviour (Bandura, 1982). AoA is essential for fostering a sense of control and responsibility over one's decisions which is vital for effective self-regulation. Executive functions support awareness of action by enabling individuals to monitor and regulate their behaviours in real-time. Baddeley's model of working memory (Baddeley, 1992) illustrates how these functions facilitate the execution of decisions in alignment with predetermined goals.

This is particularly relevant for workers who must perform specific tasks while maintaining awareness of their actions to ensure effectiveness. The capacity to regulate one's behaviour in accordance with established objectives is crucial for achieving desired outcomes in various professional contexts.

Closely related to the concept of AoC and AoA is Flavell's metacognitive theory (Flavell, 1979), which focuses on the understanding of cognitive processes and the ability of individuals to reflect on their own thoughts and learning strategies. The theory is comprised of two main components: i) metacognitive knowledge, which includes knowledge about one's own cognitive processes, abilities, and factors influencing learning (similarly to AoC); and ii) metacognitive regulation, which refers to the ability to monitor, control, and regulate one's cognitive processes (similarly to AoA).

To sum up, AoC and AoA are interconnected constructs that play a pivotal role in effective decision-making. The ability to critically reflect on the implications of choices, supported by cognitive processes such as episodic memory and abstract thinking, enhances the quality of decisions made. Simultaneously, awareness of one's agency and the regulatory mechanisms that govern actions are essential for fostering a sense of control and responsibility. Considering these aspects, the interplay between these two constructs might be significant in a comprehensive understanding of decision-making processes. The former could emphasize the cognitive aspects of evaluating choices, while the latter might focus on the regulatory mechanisms that control actions.

However, in cognitive psychology, working memory and decision-making are tested and evaluated with classical laboratory-based tasks, such as the binary prediction (BP) task (Rakow et al., 2010) or the Iowa Gambling task (Cui et al., 2015), which are useful and validated tasks, but they do not enable to explore the cognitive reflection and behavioural regulation in achieving effective outcomes in terms of AoC and AoA. To fill this gap, it could be useful to design novel

ecological tasks that allow gathering behavioural data during the whole managerial decision-making process (including the decision and retrieval phases, as well as the participant's awareness of the decision, in terms of choice and action).

In this perspective, it is essential to point out that research has also shown that the quality of decision-making can be influenced by several factors, internal and external to the individuals.

Among the external factors, significant importance is given to time pressure and incentives. Indeed, within organizations, professionals are often called upon to make decisions in a short time, under pressure and without the possibility of confrontation with colleagues. Kocher and Sutter's study indicated that tight time constraints can impair information processing and the consistency of decision-making, ultimately reducing the quality of choices made (Kocher & Sutter, 2006). Furthermore, the concept of bounded awareness, as discussed by Chugh and Bazerman, suggests that individuals may fail to recognize important information that could influence their decisions (Chugh & Bazerman, 2007). This phenomenon highlights the limitations of human cognition in decision-making contexts, emphasizing the need for strategies that enhance awareness of relevant factors that may otherwise be overlooked. By fostering a greater understanding of the factors influencing choices, individuals can improve their decision-making outcomes.

On the other hand, as previously mentioned, to fully and thoroughly investigate the relationship between working memory and decision-making, it is also important to consider internal factors of the individual, first and foremost his or her personality traits. In this perspective, a review of the literature reveals that the actual gold standard to investigate personality seems to be based on questionnaires such as the 10-item Big Five Inventory (BFI; Guido et al., 2015) and the Maximization Scale (MS; Nenkov et al., 2008; Schwartz et al., 2002). Specifically, the first questionnaire is aimed at investigating five personality traits in terms of (i) extroversion; (ii) agreeableness; (iii) conscientiousness; (iv) emotional stability; and (v) open-mindedness. On the other hand, the second questionnaire explores the decision makers' tendencies to be a "satisficer," someone content with an adequate or "good enough" solution, or a "maximizer" who seeks out the best possible option, according to three main dimensions (the tendency to hold high standards, to seek better alternatives and the difficulty in deciding).

Interestingly, Faure and colleagues (2019) evidenced that maximization varies throughout the lifetime, with younger persons typically being more maximizers and older adults being more satisficers. These results could imply that maximizing may decline with advancing age. This shift in decision-making styles is supported by research indicating that as individuals age, their emotional regulation and cognitive strategies evolve, leading to different

approaches in evaluating choices and experiences (Montepare & Dobish, 2013). According to the authors, younger adults often engage in maximization as a reflection of their developmental stage, where exploration and the pursuit of optimal outcomes are prevalent. This behaviour aligns with findings that younger individuals are more likely to report higher levels of positive affect and engage in riskier decision-making, which can be attributed to their greater cognitive flexibility and lower levels of emotional regulation. In contrast, older adults, who have accumulated life experiences, may prioritize emotional well-being and stability, leading them to adopt satisficing strategies that focus on contentment rather than perfection. This transition can be seen as a coping mechanism, allowing older adults to navigate the complexities of life with greater ease and satisfaction (Balconi et al., 2009; Balconi & Lucchiari, 2005).

Moreover, the distinction between maximizers and satisficers has implications beyond individual decision-making. For instance, in organizational contexts, leaders who identify as maximizers may engage in extensive information search and analysis, potentially leading to decision paralysis, while satisficers may make quicker, albeit less optimal, decisions that can still yield satisfactory outcomes (Kim & Mason, 2020). This dichotomy is essential for understanding how personality traits influence behaviour across different life stages and contexts, emphasizing the need for tailored approaches in both personal and professional settings.

Starting from this evidence, it is important to note that, alongside personality traits, another important variable to consider in studying the decision-making process and working memory function is the expertise of individuals. Concerning the incidence of this factor in decision-making, the literature emphasized how performance in some tasks is strongly tied to an individual's experience (Bruine de Bruin et al., 2012), as the level of professional expertise within an organization. For example, it has been shown that getting older can influence working memory tasks, as well as the propensity to take on more responsibility (Cauffman et al., 2010). Nevertheless, is also evidenced that older people do not always perform more poorly than younger people when making decisions (Mather, 2006). Moreover, in a study focused on exploring the awareness of decisions in terms of retrospective judgments about their quality, it was found that neither young nor seniors showed substantial underconfidence or overconfidence. In addition, it has also been shown how aspects such as task knowledge or prior decision-making experience can determine the accuracy of retrospective performance estimates (Hershey & Wilson, 1997).

Regarding organizational setting, previous studies explored the role of working memory in decision-making (Balconi et al. 2024), and demonstrated that seniority and work expertise could influence the decision-making process (Acconito et al., 2024; Angioletti et al., 2024; Slaughter et al., 2011). However, to the best of our knowledge, no previous study has specifically focused on

analysing any age-related differences in terms of AoC and AoA. Therefore, the impact of expertise on decision-making processes related to working memory (in terms of achievement and retrieval) remains still open.

Starting from this theoretical premise and the evidence of this gap in the literature, the present work investigated the behavioural correlates of next-generation and experienced professionals performing a novel dual task that attempts to explore the accuracy (ACC) of AoC and AoA, after an achievement phase, using real-life ecological situations related to decisions. Moreover, to increase the ecology of the task in terms of correctly representing organizational situations where people work under pressure and with time constraints, professionals had a maximum 20-second time window to make their choice and remember what they did. This, moreover, made it possible to collect response times (RTs), an index of cognitive effort and workload (Kramer, 2020). Also, the personality traits and individual characteristics of professionals were assessed with BFI and MS.

Going down to specifics, it was expected to observe statistically significant differences in terms of awareness, with less ACC in AoC compared to AoA. This hypothesis is based on the metacognitive theory and the idea that actions are more tangible and observable, whereas thought processes are more abstract and difficult to monitor. Therefore, people could have more difficulties in remembering the choice made in the first phase of the task rather than the action, having greater awareness of their actions than their thought processes.

In line with this perspective, it is also possible to hypothesize that being aware and remembering the action previously performed, compared to the stream of thoughts that led to a particular choice, takes less time. Therefore, higher RTs are expected in AoC compared to AoA.

Moreover, since no previous study has investigated expertise-related differences in AoC and AoA in professional groups, we are interested in exploring potential differences between the two samples considered.

Finally, as far as individual characteristics are concerned, it is possible to hypothesize a positive correlation between AoC and the tendency to maintain high standards, since people who tend to maximize the outcome of decision-making processes by striving and actively searching for the best available option are also those who inevitably consciously weigh all the advantages and disadvantages of each alternative and, therefore, are aware of the choice made. On the other hand, regarding the specific correlations between personality in the junior and senior group, differences can be assumed. However, since no previous study has investigated the constructs of AoC and AoA in these professional groups, it is not possible to predict the direction of correlations.

2. Method

2.1 Sample

A sample of 117 healthy individuals was enrolled on the study and divided into two groups: next-generation and experienced professionals. Before starting the participants' recruitment, to determine the minimum sample size required for the study, a priori power analysis for repeated measures ANOVA was conducted using G*Power software (Heinrich-Heine, Düsseldorf, Germany), version 3.1.9.7 (Erdfelder et al., 2009; Faul et al., 2007). Results indicated that for repeated-measures ANOVA with two measurements and two groups, a total sample size of 54 individuals was the minimum for achieving 80% power and detecting a medium effect ($f = 0.25$), at a significance criterion of $\alpha = 0.05$. Thus, the obtained sample size of $N = 117$ is adequate.

Specifically, the next-generation group was characterized by 75 individuals (M_{age}= 20.65; SD_{age}= 1.87) who had finished their studies and were about to officially enter the labour market and, at the same time, already had minimal short work experience. On the other hand, the group of experienced professionals was composed of 42 individuals (M_{age}= 40.77; SD_{age}= 11.87), already established in the world of work and with a minimum expertise of 2 years. Moreover, this group was enrolled in partnership with various medium-to-large Italian companies across different sectors. Furthermore, to enhance the generalizability of the findings and minimize potential bias, the professionals represented a range of specializations, working in diverse roles such as infrastructure management, engineering management, human resource management, training, and professional development.

Generally, all groups were recruited according to the following exclusion criteria: i) low cognitive functioning; ii) severe levels of depression; iii) history of neurological or psychiatric disorders; iv) abnormalities in short- or long-term memory; and v) therapy with psychoactive drugs that could alter cognitive or decision-making abilities. Moreover, all participants had normal to correct vision and participated in the study providing written informed consent and without receiving any monetary compensation.

The study was carried out in accordance with the Declaration of Helsinki (2013), according to the GDPR - Reg. UE 2016/679 and its ethical guidelines and approved by the Ethics Committee of the Ethics Committee of the Department of Psychology of the Catholic University of the Sacred Heart, Milan, Italy.

2.2 Procedure

The experimental procedure occurred in a quiet room, where participants sat on a comfortable chair and had a computer monitor approximately 80 cm away from their eyes.

After signing the informed consent, all participants received the instruction to perform a novel dual task that attempts to explore the ACC of AoC and AoA, administered via a web-based survey and experiment-management platform (PsyToolkit, version 3.4.4) (Stoet, 2010, 2016). After the conclusion of the task, the MS and the 10-item BFI were administered to gather information about the individual characteristics and personal traits of participants. Overall, the experiment lasted approximately 15 min.

2.2.1 Behavioural data collection: the novel dual task

To collect behavioural data, a novel dual task was created ad hoc to explore participants' decision-making ability and awareness of decisions made, both in terms of choices and actions. Specifically, the task was constituted of two phases: the achievement phase and the retrieval phase.

First, in the achievement phase, fifteen real-life ecological decisional scenarios related to organizational world were presented to participants. Specifically, as a first step, participants were asked to identify with the situation and were instructed with the following sentence:

"You have just been hired at a new company and you are still not familiar with the structure. You start on your first day and have to perform some bureaucratic tasks."

Then, after the previously described frame of reference, the participants were asked to choose from some alternatives and answer some questions, making a real journey. Indeed, in some scenarios, participants had to decide between two options related to navigating various workplace challenges, such as finding an office, interacting with colleagues, and managing their time effectively (i.e., *"The personnel office asks you to bring a packet of documents about your employment to the B31 office of the chief of staff, but you don't know where it is. How do you orient yourself to find out where this office is located? Do you ask the secretary or consult the building map?"*). In other scenarios, instead, participants were required to perform an action, such as inputting a phone number or selecting a specific area on the screen corresponding to the correct response (i.e., *"Arriving on the fifth floor, as you pass by the elevator, a gentleman approaches carrying a large box. Since his hands are busy, he politely asks you to call the elevator for him so that he can go down to the ground floor without using the stairs. Click one of the three buttons to choose the desired action"*).

Furthermore, to enhance the realism of the task by accurately reflecting organizational situations where individuals work under pressure and face time constraints, participants had a maximum 20-second time window to decide and achieve each step of the journey.

On the other hand, in the retrieval phase, participants were asked to think about the journey they had just taken and recall their previous decisions and actions. Specifically, they were shown the following instructions:

"Reviewing the path you have just taken, now answer the following questions by selecting one option from those proposed."

Each question presented four options, from which participants had to choose the correct one based on their memory of the achievement phase (i.e., "*When you called the elevator, what colour was the button you pressed? (a) green; (b) blue; c) yellow; d) don't remember"*). Moreover, similarly to the achievement phase, professionals were given a maximum of 20 seconds to recall their choices and actions and select the correct option. The administration of the task under time pressure made the decision-making process mentally demanding and RTs useful and discriminative indicators of cognitive load and information processing effectiveness.

For each scenario, the response score and RTs were collected as performance measures of awareness of the decision. Specifically, considering separately the scenarios that required a choice and those that required action, two accuracy scores were calculated, the AoC and AoA's ACC, as the ratio of the number of correct responses to the total number of responses.

Indeed, the AoC's ACC represented the level of correctness in recalling to memory the decision made in the scenarios that required a choice. In other words, it indicated the consistency level between the decision made in the achievement phase and what was remembered and reported in the retrieval phase.

Similarly, the AoA's ACC represented the level of correctness in recalling to memory the decision made in the scenarios that required an action. In other words, it indicated the consistency level between the action made in the achievement phase and what was remembered and reported in the retrieval phase.

Alongside the ACC indices, RTs were also calculated for both AoC and AoA, as the average of the time used in the retrieval phase.

2.2.2 Psychometric data collection: BFI and MS

To explore individual differences the 10-item BFI and the MS were administered.

The 10-item BFI (Guido et al., 2015) is a brief scale developed to assess in a very short amount of time the five personality traits: extroversion (characterized by enthusiasm and sociability), agreeableness (marked by likability and warmth), conscientiousness (defined by organization and self-

discipline), emotional stability (reflecting calmness and balance), and openness (involving creativity and receptiveness to new experiences). Participants rate their responses using a five-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Higher average scores on a subscale reflect a stronger presence of the corresponding personality trait.

On the other hand, the MS (Nenkov et al., 2008; Schwartz et al., 2002) is a questionnaire comprising 13 items in which individuals rate their level of agreement on a 7-point Likert scale. This scale measures decision-makers tendencies in three areas: (i) setting high standards for themselves and in general (the high standard subscale), (ii) seeking better alternatives (the alternative search subscale), and (iii) experiencing difficulty in making decisions (the decision difficulty subscale).

2.3 Data analysis

Initially, before conducting statistical analyses, the normality of the data distribution was evaluated. This evaluation was done by examining the indices of kurtosis and skewness, which indicated an overall normal distribution of the data. Furthermore, as a preprocessing step for the statistical analyses, all data were standardized by transforming them into z-scores.

Firstly, to test the hypothesis, two different repeated measures ANOVAs with *Group* (2: Next-generation; Experienced professionals) as a between-subject independent factor and *Awareness* (2: AoC, AoA) as a within-subject independent factor were performed on behavioural data (ACC and RTs).

When applicable, the degrees of freedom for each ANOVA test were modified according to the Greenhouse–Geisser epsilon. The size of statistically significant effects has been estimated by computing eta squared (η^2) indices. Moreover, significant interactions were explored through pairwise comparisons to evaluate simple effects. To account for potential biases due to multiple comparisons, the Bonferroni correction was applied.

Secondly, correlation analyses (Pearson correlation coefficients) were computed between psychometric data (10-item BFI scores and MS) and behavioural data (ACC and RTs), for the total sample and separately for each group.

3. Results

3.1 Behavioural results

Accuracy index. During the retrieval phase, as shown by the ANOVA performed on ACC data, a significant main effect for the *Awareness* factor was found [$F_{(1,115)}$ = 24.38, p < .001, η^2 = .064], with lower ACC for AoC compared to AoA (Figure 1a). Furthermore, a main effect for *Group* was found [$F_{(1,115)}$ = 6.17, p = .014, η^2 = .032], with lower ACC for the Experienced professionals compared to the Next-generation (Figure 1b). Finally, a significant interaction effect was revealed for *Group* × *Awareness* [$F_{(1,115)}$ = 4.42, p = .038, η^2 = .012]. Significant pairwise comparisons reported lower ACC in AoC for the Experienced professionals compared to the Next-generation (p = .020). In addition, for the Experienced professionals, a lower ACC was found in AoC compared to the AoA ($p \leq .001$) (Figure 1c).

No other significant results were found.

RTs data. During the retrieval phase, as shown by the ANOVA performed on RTs data, a significant main effect for the *Awareness* factor was found [$F_{(1,115)}$ = 136.604, p < .001, η^2 = .186], with higher RTs for AoC compared to AoA (Figure 2a).

Furthermore, a main effect for *Group* was found [$F_{(1,115)}$ = 5.34, p = .023, η^2 = .029], with higher RTs for the Experienced professionals compared to the Next-generation (Figure 2b).

No other significant results were found.

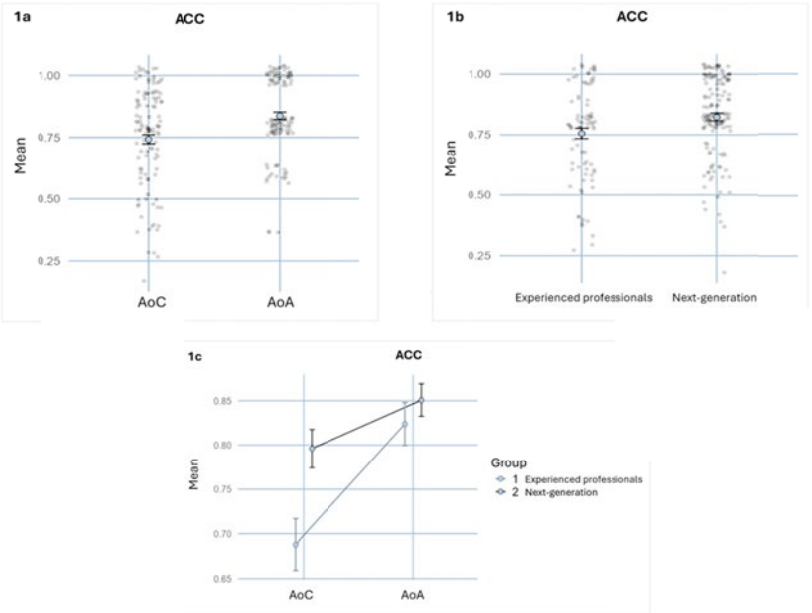


Figure 1. (a) The scatter plot displays the higher scores for the AoA's ACC compared to AoC's ACC. Each data point includes vertical Standard Error bars (SE, ±1), indicating the range of variability. The data points are evenly distributed across the Y-axis (from 0 to 1). (b) The scatter plot displays the higher scores of ACC for the Next-generation compared to the Experienced professionals. Each data point includes vertical Standard Error bars (SE, ±1), indicating the range of variability. The data points are evenly distributed across the Y-axis. (c) The line plot compares Experienced professionals' ACC and Next-generation's ACC, with data points plotted on the Y-axis (from 0 to 1)

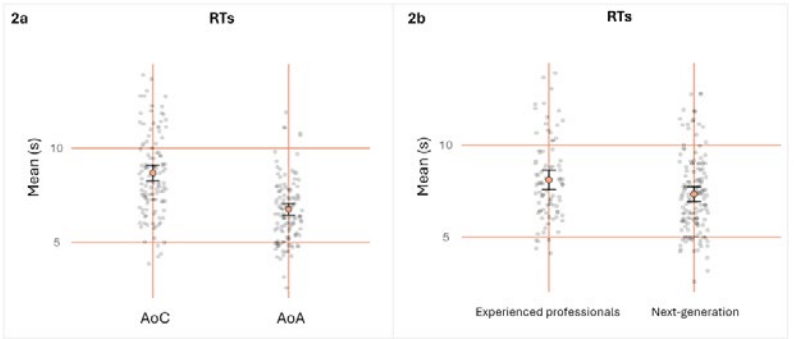


Figure 2. (a) The scatter plot displays the higher scores for the AoC's RTs compared to AoA's RTs. Each data point includes vertical Standard Error bars (SE, ±1), indicating the range of variability. The data points are evenly distributed across the Y-axis. (b) The scatter plot displays higher RTs for the Experienced professional compared to the Next-generation. Each data point includes vertical Standard Error bars (SE, ±1), indicating the range of variability. The data points are evenly distributed across the Y-axis

3.1 Correlational results

Maximization Scale. Considering the total sample, a significant positive correlation was found between High Standards and the AoC's ACC (r = .271, p = .014) (Figure 3a). Moreover, regarding correlation analyses performed on the two groups separately, the same correlation found in the total sample was reported in the Next-generation (r = .390, p = .002) (Figure 3b), but not in the Experienced professionals.

10-item Big Five Inventory. Regarding correlation analyses performed on the entire sample, no significant correlations were found. However, considering the Next-generation group, a negative correlation was found between Emotional Stability and both the AoC's ACC (r = -.338, p = .009) (Figure 4a) and the AoA's ACC (r = -.353, p = .006) (Figure 4b). On the other hand, concerning the Experienced professionals' group, a negative correlation was found between Extroversion and the AoA's ACC (r = -.433, p = .027) (Figure 4c)

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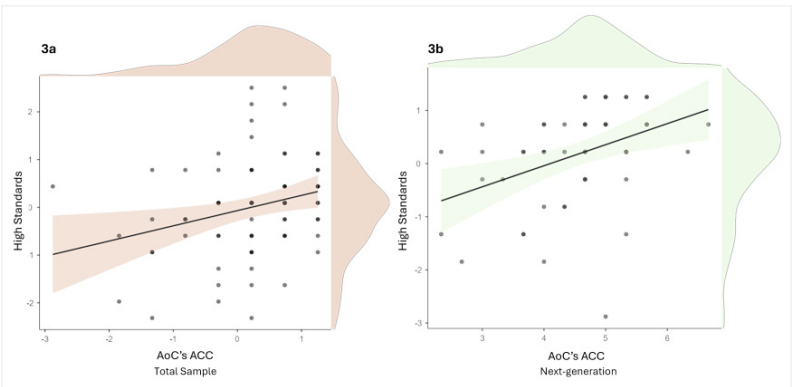


Figure 3. Scatterplots for statistically significant correlations between the following: (a) AoC's ACC and High Standards (MS) for the Total Sample; (b) AoC's ACC and High Standards for the Next Generation. The straight lines represent the global linear trends, while the shades represent their 95% confidence intervals. Light orange profiles (a) and Light green profile (b) on top and at the right of each scatterplot represent the density plots for correlated variable

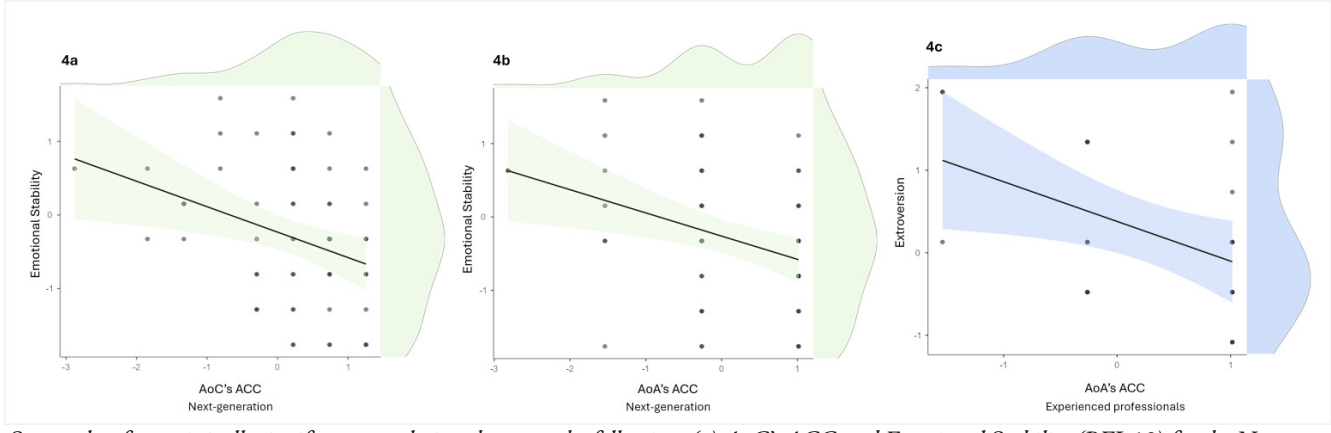


Figure 4. Scatterplots for statistically significant correlations between the following: (a) AoC's ACC and Emotional Stability (BFI-10) for the Next-generation; (b) AoA's ACC and Emotional Stability (BFI-10) for the Next-generation; (c) AoA's ACC and Emotional Stability (BFI-10) for the Experienced professionals. The straight lines represent the global linear trends, while the shades represent their 95% confidence intervals. Light green profiles (a and b) and Light blue profile (c) on top and at the right of each scatterplot represent the density plots for correlated variables

4. Discussion

The present experimental protocol was developed to study and investigate the behavioural correlates of next-generation and experienced professionals performing a novel dual task that attempts to explore the ACC of AoC and AoA, after an achievement phase, thanks to the use of real-life ecological situations related to decisions. Indeed, exploring the AoC and AoA represents a new perspective for investigating cognitive reflection and behavioural regulation in achieving effective outcomes.

Regarding the findings, and first focusing on the entire sample, lower ACC for AoC compared to AoA and higher RTs for AoC compared to AoA were reported.

Specifically, these results confirmed the first part of the study's hypotheses, which have assumed that people could have a greater awareness of their actions than their thought processes and that being aware and remembering the action previously performed, compared to the stream of thoughts that led to a particular choice, takes less time. For interpreting these results could be useful to refer to the metacognitive theory (Akturk & Sahin, 2011; Flavell, 1979; Lai, 2011), which postulated metacognitive knowledge and metacognitive regulation as components of understanding cognitive processes and the ability of individuals to reflect on their own thoughts and learning strategies. In this perspective, it could be that individuals have greater AoA as actions are more tangible and observable. On the other hand, however, thought processes are more abstract and difficult to monitor and control. Therefore, the tangibility of actions makes them easier to perceive and regulate, while the abstract nature of thought processes poses challenges to metacognitive awareness and control.

Another possible explanation could be provided by the Theory of Planned Behaviour (Ajzen, 1991), which suggests that behaviour is determined by intentions, attitudes (beliefs about a behaviour), and subjective norms (beliefs about others' attitudes toward a behaviour). Referring to this theory, indeed, it is possible to explain the discrepancy between intention and behaviour by defining intention as the thought process of choice and behaviour as the actual action. Actions, then, are more easily measurable and verifiable than thoughts, which can be more influenced by subjectivity.

This difficulty in ACC is closely related to awareness, which is the time it takes to develop AoC and AoA. Starting with the difficulties previously described about AoC, it is easy to understand how it takes longer, being thought processes more abstract and difficult to monitor and control.

A second group of interesting results concerned the significant differences between next-generation and experienced professionals. Specifically, experienced

professionals reported i) lower ACC compared to next-generation; ii) lower AoC's ACC compared to next-generation; iii) lower AoC's ACC compared to AoA's ACC; and iv) higher RTs compared to next-generation. Overall, starting from these results, it could be possible to evidence that next-generation performed better than experienced professionals and that, for this group, implementing several executive functions, including working memory, on thought is difficult.

Exploring the first result, the lower ACC in experienced professionals compared to next-generation may be attributed to the type of decision that this group of professionals are called upon to make. Indeed, experienced professionals are required to deal with complex situations, to make decisions that require greater responsibility and decision-making complexity. In this perspective, this result could be explained by introducing the concepts of cognitive complexity (Halford et al., 1998) and cognitive overload (Sweller, 2010; Sweller & Chandler, 1991). Regarding cognitive complexity, it is good to highlight how complex decisions require a greater ability to manage and integrate multiple information. From this perspective, then, it could be that the complexity of decisions made by seniors is a reason for lower accuracy since they have to integrate multiple pieces of information within a short time compared to next-generation who hold roles with less responsibility. On the other hand, the excess of information and responsibility typical of high-level job positions can lead to a reduction in cognitive processing capacity, which in turn affects decision-making accuracy.

On the other hand, the lower AoC's ACC in experienced professionals compared to next-generation could be supported by the notion of heuristics (Gigerenzer & Gaissmaier, 2011), defined as the subset of strategies that permit to make decisions quickly, frugally and accurately by ignoring parts of available information. Indeed, experienced professionals, due to the dynamic and complex environment in which they work, may be forced to make decisions quickly, almost automatically and unconsciously, without having a way to pay attention to details or to implement critical reflection on what they are doing and thinking. The dynamic environment and the need to make quick decisions combined with professional experience would then lead to unconscious and autonomous decision-making, unlike young people who, on the other hand, being in their first work experience and holding roles with less responsibility, pay more attention to the thought process that leads them to make decisions. However, it is important to highlight how this decision-making automatism and little AoC might not impact the quality of decisions. From this aspect, future studies could investigate decision-making quality and effectiveness in relation to the level of awareness.

Closely related to this concept might also be the third result previously enumerated, which highlighted how in the experienced professionals group a

lower AoC's ACC than AoA's ACC was found. Since experienced professionals might often act autonomously and unconsciously (Gigerenzer & Gaissmaier, 2011), and since actions are more tangible and observable than thought processes (Akturk & Sahin, 2011; Flavell, 1979; Lai, 2011), which are more abstract and difficult to monitor and control, therefore, it might be that for this category of professionals could be easier to have awareness of their actions, for which there is easy feedback of their agency (Andreou, 2013; Bandura, 2006; Haggard & Eitam, 2015).

While this significant difference between AoC's ACC and AoA's ACC was found for experienced professionals, it is interesting to point out that this was not reported in the next-generation group. This lack of significance would seem to highlight that, in this second group, the level of ACC did not vary between AoC and AoA. One possible interpretation of this finding could be attributed to the greater amount of time that entry-level workers have. Since they are in their first work experiences and do not have to deal with critical issues by making quick decisions, they may pay more attention to the decision-making process, becoming aware of choices as much as actions, also because they are likely to have to subsequently report what they have done to their supervisors.

Finally, the last results concerned the significant differences between experienced professionals and next-generation, with higher RTs in the decision-making process of the latter group than the former. This evidence, specifically, turns out to be in line with what has been shown so far. Indeed, experienced professionals, reporting lower levels of ACC than next-generation as well as operating autonomously and unconsciously, need more time to remember thought processes and actions enacted.

The last group of findings regarded the correlation analyses, performed on the entire sample and the two different groups.

First, the entire sample reported a significant positive correlation between High Standards and the AoC's ACC. Referring to the meaning of this MS subscale (Nenkov et al., 2008; Schwartz et al., 2002), it is important to point out that people defined by this approach to decision-making seek the best for themselves, which is positively correlated with the need for cognition and problem analysis. Therefore, in this perspective, having high standards involves paying attention to and becoming aware of the process that led to that choice, as a result of the alternatives evaluation. This consequently leads to a greater awareness of one's thoughts and accuracy of retrieval (high level of AoC's ACC).

On the other hand, concerning the experienced professionals, a negative correlation was found between Extroversion and the AoA's ACC. Specifically, the extraversion trait is typical of active, spontaneous, talkative, dominant people (Guido et al., 2015). Moreover, this trait was previously associated with impulsivity in a decision (Quilty et al., 2014; Whiteside & Lynam, 2001).

Following these literature perspectives and highlighting the dynamic and fast-paced environment in which experienced professionals work, it is, therefore, possible to support the idea that these workers, characterized by high levels of extroversion, tend to act on impulse, without consciously reflecting on what they are doing, to cope with the constant demands of the environment as well. This attitude, however, might be reflected in a lower ACC of retrieval the action done.

Finally, the next-generation group reported: the same correlation found in the entire sample (positive correlation between High Standards and the AoC's ACC) and a negative correlation between Emotional Stability and both the AoC's ACC and the AoA's ACC.

Specifically, the first correlation confirmed the perspective of Montepare & Dobish, who evidenced that younger adults, in contrast with senior adults, engage in a maximization process, where exploration and the pursuit of optimal outcomes are prevalent (Montepare & Dobish, 2013). Additionally, according to the significance of this MS subscale (Nenkov et al., 2008; Schwartz et al., 2002), people with high standards search for the best results with the need for cognition. Therefore, according to these points of view, the next-generation group spends time, energy and cognitive resources to achieve high standards by evaluating different possible options. This process, in which conscious decision-making is required, is reflected in greater ease in remembering what has been done and, consequently, in high levels of AoC's ACC.

Concerning the last enumerated correlations, it can be deduced that higher levels of Emotional Stability are correlated with lower ACC and, therefore, less ability to be aware of the choices and actions made. For interpreting these results, it might be useful to refer to the concept of rational versus intuitive information processing. Indeed, previous studies have shown that the trait of emotional stability seems to be associated with an intuitive and emotional style of thinking and decision-making (Crivelli et al., 2024a; Pacini & Epstein, 1999; Reyna & Ortiz, 2016; Whiteside & Lynam, 2001). In this sense, therefore, people characterized by this trait would process information quickly, intuitively, without awareness of the cognitive process implemented (which is instead present in a rational style). From this background, it is, therefore, possible to understand how people with this personality trait have greater difficulty in remembering the thought processes enacted to make choices and actions, translating into a lower level of ACC in the retrieval phase of the task used in this study.

To sum up, this study represents the first attempt to explore the behavioural correlates of AoC and AoA's ACC in next-generation and experienced professionals performing a novel dual decision-making task. The findings evidenced how experienced professionals have lower levels of ACC than next-generation and how AoC turns out to be more difficult and

cognitively demanding compared to AoA, maybe because thought processes are abstract and difficult to monitor and control. The lower level of awareness of experienced professionals, instead, could be attributed to work experience and the work environment itself, where these professionals are called upon to make complex, intuitive, and rapid decisions.

However, despite the innovativeness of this study, some limitations should be highlighted. First, this study is based solely on the collection of behavioural data and psychometric measures. Instead, to fully understand the AoA and AoC, it might be useful to employ the recent neuroscientific approach (Acconito et al., 2023; Balconi, 2021; Butler et al., 2015) which allows us to study not only the explicit aspects but also the implicit ones. Specifically, it might be interesting to adopt a neuroscientific and multi-level protocol based on electroencephalogram (EEG) and biofeedback, as well as on behavioural data. Indeed, EEG and biofeedback permit to mapping of the neuro- and psycho-physiological response during the decision-making process, highlighting levels of cognitive and attentional effort in information processing and emotional engagement (Balconi et al., 2023, 2024; Balconi & Fronda, 2019; Crivelli et al., 2024a; Forte et al., 2021; Lim et al., 2019). Moreover, from a methodological point of view and from the interpretation of the results, it might also be interesting to explore how individuals' decision-making style (explored with General Decision Making Scale; Scott & Bruce, 1995) and information processing style impacts AoC and AoA. Indeed, previous studies have shown how these aspects can be variables that impact decision-making and executive functions (Angioletti et al., 2024; Crivelli et al., 2024a; Pacini & Epstein, 1999). Finally, to test the robustness and generalizability of the results, it would be interesting to replicate the same protocol on different samples. Indeed, further studies could be conducted on different groups of professionals from different organizational settings (e.g., consultants, engineers, computer scientists, HR managers) but also specific groups (e.g., emergency professionals, experienced decision-makers, people with decision-making problems.

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