A Gamified Sorting Test to Assess Cognitive Flexibility in Personnel Selection:

A Pilot Study

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Abstract—Cognitive flexibility is a critical Executive Function (EFs) that can be broadly defined as the ability to adapt behaviors in response to changes in the environment, it is more and more crucial in workplace. First, this paper is aiming to present the theoretical framework implied in assessment of cognitive flexibility for personnel selection and recruitment. Second this paper is aiming to present the protocol of an experiment conducted (i) to investigate the behaviours and performances of users/players with the gamified version of sorting test and (ii) to compare their performances with the traditional paper-and-pencil version of the Wisconsin Card Sorting Test (WCST), which is the most popular and the most used standardized test used to assess cognitive flexibility.

Keywords—*cognitive flexibility; human-machine interaction; assessment; personnel selection*

I. INTRODUCTION

Cognitive flexibility, the ability to flexibly switch between tasks, is a core dimension of Executive Functions (EFs) allowing to control actions and to adapt flexibly to changing environments. It supports the management of multiple tasks, the development of novel, adaptive behavior and is associated with various life outcomes.

Historically, the assessment of cognitive flexibility was developed for clinicians to support diagnosis and treatment for patients with frontal lobe damage and/or cognitive difficulties [1][2][3], such as older people and has been progressively extended to other pathology such as anorexia [4] or schizophrenia [1].

But because cognitive flexibility is a critical executive function that can be broadly defined as the ability to adapt behaviors in response to changes in the environment, it is more and more crucial in workplace [5][6][7]. Moreover recent changes in the nature of work require that employers reassess the modus operandi of their personnel selection procedures. In particular, employees are increasingly expected to switch seamlessly between different job roles, tasks, organizations, and even occupations. In other words, to assess cognitive flexibility is more and more crucial during personnel selection because this non-technical skills became central (Figure 1).
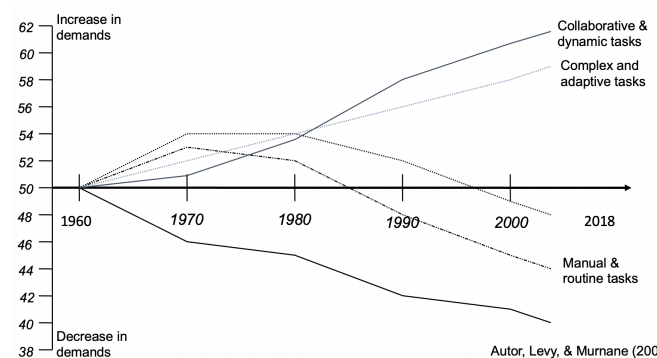

Figure 1. Increase of demand for non-technical skills and executive functions such as cognitive flexibility in workplace across time, based on [8].

This paper is aiming (i) to present an innovative digital tool (i.e., a gamified sorting test) specifically created to assess cognitive flexibility for personnel selection and (ii) to present results issued from an experiment to compare performances and acceptability with "traditional" tool.

A. Defining and measuring cognitive flexibility

Cognitive flexibility refers to the ability to shift attention between task sets, attributes of a stimulus, responses, perspectives, or strategies [9][10]. In the scientific literature, it is also referred to by shifting, attention switching, or task switching, and includes both the ability to disengage from irrelevant information in a previous task and to focus on relevant information in a forthcoming task [11]. Thus, cognitive flexibility enables to think differently, change perspective and adapt to a continuously changing environment.

In cognitive ergonomics, most psychological theories (e.g., Rasmussen: [12][13]; Reason: [14]; Norman: [15][16]; Hollnagel: [17]; for a synthesis [18]) are agree on the idea that in order to avoid human error, an individual needs to realize that the situation has changed in order to be able to 'log out' of the automatic processing mode and come into the controlled processing mode. To detect the situation change

and the necessity of a non–routine response, it is necessary to come into a higher level of attentional control, where the individual accesses the new situation and plan the action to be taken. They need to perceive the environmental cues in a different way, reinterpreting them. How the person represents the task and the set of strategies employed to deal with it determines how easily she or he will shift attention to the new environmental conditions.

Cognitive flexibility can be assessed with a variety of neuropsychological tests, the most prominent being the Wisconsin Card Sorting Test (WCST [1][3]). In this test, participants are asked to sort a series of cards according to different rules and alter their strategy when the rules change unexpectedly (Figure 2). The figure 2 depicts a response card with two blue stars. The stimulus cards are from left to right; one red triangle, two green stars, three yellow crosses, and four blue circles. In the manual administration, the four stimulus cards would be laid on a table in front of the participant, and the participant is handed a deck of multidimensional response cards to sort. Typically, individuals who are less cognitively flexible struggle to adjust to changing rules, while those with higher aptitude can quickly switch their mode of thinking between an efficiency-driven adherence to a given rule and the exploration of new approaches. As this test was originally designed for clinical use to detect executive dysfunction, its suitability for assessing performance in a personnel selection context has yet to be investigated.
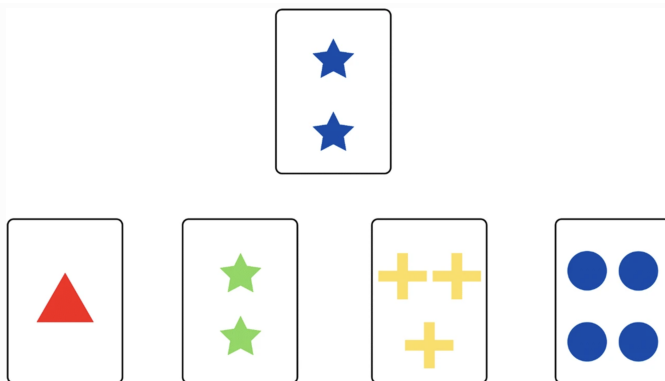

Figure 2. An example of the WCST display

B. Assessment of cognitive flexibility in personnel selection

As Hommel et al. [19] say in their paper published in 2021, recent changes in the nature of work require that employers reassess the modus operandi of their personnel selection procedures. In a fast-changing knowledge economy, employees need to adapt quickly to novel demands, make decisions in the face of uncertainty, and cope with unexpected challenges [20]. At the same time, employees are increasingly expected to switch seamlessly between different job roles, tasks, organizations, and even occupations [21]. To ensure sustained firm performance, organizations need a workforce with the necessary capacities to efficiently deal with ongoing transformation [22]. For this reason, adaptability and flexibility

have been widely acknowledged as key transversal skills that play a vital role in the long-term success of employees and, in turn, organizations [18][23]. To keep up with the demands of today's dynamic and diverse workplaces, personnel selection researchers and practitioners need to reconsider what and how to assess in the 21st century [24]. In other words, as working conditions become more and more dynamic and complex nowadays, the ability to adapt thoughts and behaviors according to changing context requirements becomes particularly relevant for work success [19][25]. Whatever the context and whatever the domain, cognitive flexibility can be defined as the ability to adjust cognitive processing strategies in response to new, changing, and unexpected circumstances, conditions and situations [26]. It enables people to switch from one activity to another, to consider multiple perspectives, to find new solutions to a problem, and to face novel conditions in the environment [19]. In contrast, individuals who are cognitively inflexible, struggle to adapt their strategies when situations change and, therefore, tend to get stuck in habitual patterns. The ability to shift cognitive sets is a key property of efficient executive functioning and has been found to be different from cognitive abilities [25].

C. Gamification in personnel selection

Gamification is used as an umbrella term comprising a variety of techniques inspired by research in game design and generally refers to the integration of game design elements into nongame contexts [27][28][29]. The primary idea is to take advantage of the motivational nature of games to enhance the effectiveness of existing methods. By tapping into people's natural desire for competition and achievement, gamification promises to encourage participation, to increase productivity and, thus, to improve the quality and quantity of outcomes in any domain. Over the past few years, gamification has been increasingly applied within a variety of areas, including work, education, training, marketing, healthcare, wellness, and sustainability [5][30].

More recently, researchers and practitioners within the field of human resource management and organizational psychology have recognized gamification as a promising tool to improve recruitment and personnel selection. The central goal of using gamification within this context is to make the selection procedure more enjoyable while increasing the quality of measurement at the same time [30]. Nevertheless, if the use of gamified versions of the WCST is becoming more common for patients (e.g., [31][32]), we found only one gamified sorting test for personnel selection created by [27]. During the game, the participant/player is asked to imagine to be a fictive employee of a marketing agency and s/he is asked to implement a new marketing strategy to reduce costs and improve the efficiency of marketing campaigns for consumer products. As in the traditional version of the WCST, the correct matching rule is not revealed to the subject. Interesting results based on a sample of 180 participants in an online study have been collected by [27].
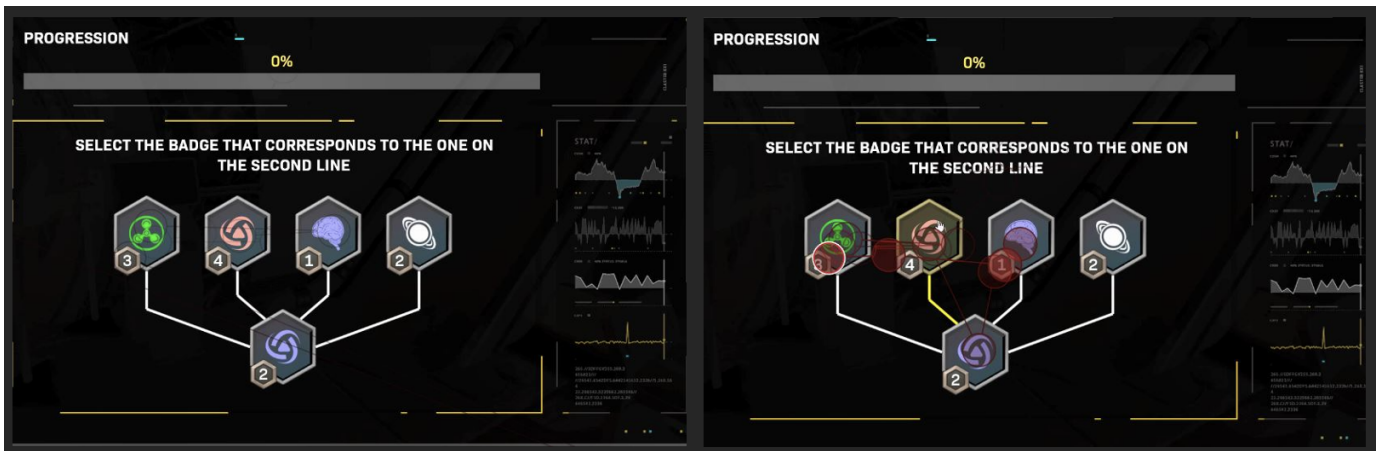
Figure 3. A screenshot of the gamified test created by Yuzu© (on the left side) and visual exploration of one participant collected by using eye-tracking technique (on the right side).

Figure 4. One of our participants while she is playing to Yuzu©, in front of the eye-tracking system.

But, according to us, even if this gamified test is interesting, this is not a relevant solution for personnel selection for several reasons:

- All the tasks are based on language, i.e., the participants/players must read and understand instructions and complex information to complete the task. One of the main advantages of the WCST is that no language is necessary to complete the test. In other words, with the environment created by [27], language can be a serious barrier.
- Because this digital environment has been created there are 10 years ago, realism and quality of graphics are very simple, no dynamic and not immersive.
- At the origin, the WCST has been elaborated to assess cognitive flexibility, i.e., the ability to shift attention between task sets, attributes of a stimulus, responses, perspectives, or strategies whatever the context. In the

digital environment created by [27], technical skills and declarative knowledge are crucial to solve the problems. In other words, only technical and declarative knowledge, which are assessed in their digital environment while the non-technical skills and executive functions are assessed by the WCST.

- Finally, data collected by the authors are only subjective data obtained by an online study using different Likert-scales. No objective data have been collected; Thus, its prevents generalization of the results.

To answer to all these limits, a gamified sorting test has been specifically created to assess cognitive flexibility for personnel selection.

II. OUR PILOT STUDY : WORK IN PROGRESS

An innovative gamified sorting test has been created specifically for personnel selection and recruitment (https://yuzu.hr). This gamified sorting test, called Yuzu©, has several components centred on specific crucial soft-skills; for each of these components, the player/user is asked to complete gamified tasks where the protocol is very similar to paper-and-pencil version of psychometrics tests such as WCST (e.g., Figure 3).

Since several months, an experiment is conducted (i) to investigate the behaviours and performances of users/players with Yuzu© and (ii) to compare their performances with the traditional paper-and-pencil version of the WCST.

For our pilot study, twelve adults volunteers are asked to play with Yuzu© and, two weeks later, to complete the paper-and-pencil version of the WCST. In other words, each participant is asked to complete the test for assessing cognitive flexibility twice.

To collect gaze data, we used the research system Tobii Pro Spectrum at speeds up to 200 Hz (Figure 4), to capture the eye movements such as saccades, tremors, and micro-saccades. This system can capture data in high sampling frequency, while still allowing for natural head movement.

In our pilot study, the main indicators are:

- The percentage of errors (i.e., total number of errors divided by number of trial administered).
- The percentage of preservative errors (i.e., number of errors in which a subject continuously respond incorrectly using the same pattern).
- Visual exploration on each card of the test (Figure 3).

Data are actually collected and the results will be presented during the conference.

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