



Short Communication

Associations between Extraversion and Working Memory: A facet-level correlational research

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ABSTRACT

Background: Empirical findings on the Extraversion – Working memory (WM) correlation don't seem to point to a relation between them, even though this relation is widely expected to emerge due to the neurophysiological underpinnings they seem to share. On previous research, Extraversion was assessed mostly at factor level, excluding the facets. In case there was a connection between WM and few specific facets of Extraversion, it could have been overshadowed by those which don't take part on it. Thus, the aim of this study is to seek for significant facet-level Extraversion – WM correlations.

Method: WM performance and Extraversion were assessed in a sample of 87 participants using a 2 n-back task and six facet-level Extraversion scales of the International Personality Item Pool.

Results: Significant correlations emerged between facet E1 (Friendliness) and efficacy (error rate), and between E3 (Assertiveness) and efficiency (median reaction time) in the WM test.

Conclusions: The friendliest and most assertive people tended to show a slightly worse WM performance than the ones with lower scores on such facets. Thus, WM doesn't seem to be related with Extraversion, but with only two of its indicators.

1. Introduction

One reoccurring question in personality research is how personality and cognitive abilities relate. More specifically, how Extraversion (EX) trait and Working memory (WM) performance relate to each other. In the present study, we examined the associations between the facets that compound the Extraversion trait, on one hand, and the performance on a WM task, on the other.

Personality is defined as a set of internal dispositions, stable over time and consistent through different situations, which explain the tendency of an individual to behave in a specific way in normal situations. These internal dispositions can be quantitatively recorded in traits (Bermúdez, García, Ruiz, Sanjuán, & Rueda, 2012). From a factorial approach, in the Five Factor Model (Costa & McCrae, 2008), Extraversion trait is defined as the tendency to enjoy social interactions, group activities, and to seek for excitement and positive emotions. It's divided in six facets: Friendliness, Gregariousness, Assertiveness, Activity Level, Excitement-Seeking, and Cheerfulness.

On the other side, executive functions (EF) are the set of higher cognitive processes necessary to plan, organize, guide, and regulate

behavior to adapt effectively to the environment (Chan, Shum, Touloupoulou, & Chen, 2008). Miyake et al. (2000), cited in Campbell, Davalos, McCabe, and Troup (2011), differentiate three types of executive functions: (a) goal alternation, (b) selective inhibition of task-irrelevant stimuli and behaviors, and (c) information refreshing or updating. Working memory (WM) is the EF involved in the latter. As described by Waris, Soveri, Lukasik, Lehtonen, and Laine (2018), WM is a mental workspace of limited capacity that allows processing information that is currently active.

The behavioral results on the correlation between Extraversion and WM don't seem to point to a relation between them: Even though some studies provide evidence on factor-level EX – WM relationship (e.g., Campbell et al., 2011), it tends not to emerge in experimental designs (Waris et al., 2018). These findings directly confront with inferred/expected relations between both variables coming from the neurophysiological underpinnings they seem to have in common, which rely mainly in (a) shared EEG, ERP and fMRI cortical activity patterns in Dorsolateral Prefrontal Cortex (DLPFC) (see Lei, Yang, & Wu, 2015; Nostro et al., 2018) and (b) effects of direct stimulation on DLPFC in WM training (e.g., Au et al., 2021).

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In addition to the lack of technical consensus among researchers, which has led to difficulties on taking a comprehensive view of the results and draw conclusions (Murdock, Oddi, & Bridgett, 2013), one consistent fact is that most of the studies assess Extraversion as a single measure/trait (Lei et al., 2015), which means facets tend not to be neither assessed nor included in correlational analyses with working memory. That is, differential correlations between facets and WM are not frequently calculated.

It's important to remark the importance of facets in personality research: since the factors are theoretical constructs for which we don't have a direct unit of measure, like meters for length, we must rely on the methodology proposed by Campbell and Fiske (1959), the convergent validation through multitrait-multimethod matrix (MTMM), so we can measure them.

MTMM methodology assumes that empirical measures/indicators of the same construct have common and specific variance, and the common variance corresponds with the construct itself. This means that Extraversion is, at last, a common property shared by its empirical indicators: the facets. If only few specific facets correlated with WM, this would mean that there is no connection with Extraversion, property shared by all facets, but only with one or two of them.

Analyzing personality attending to facets, rather than factors, is a recommendation already proposed in previous research (Lei et al., 2015), but little explored. Thus, the objective of the current study is to test if statistically significant correlations can emerge between specific Extraversion facets and the performance on a WM task.

2. Method

2.1. Sample

By incidental sampling 87 Spanish anonymous volunteers participated (41 men, 46 women). The mean age was 37.95 years (s.d. = 16.22).

2.2. Materials and procedure

Firstly, the participants gave their informed consent to participate in the study. Subsequently they completed a sociodemographic survey, six Extraversion facet scales, and performed the n-back task.

2.2.1. Sociodemographic Survey

In which each participant had to indicate sex, age, level of education attained, whether he/she has undergone any treatment with psychotropic drugs in the last six months, and whether he/she has received a Mental Health diagnosis over the last year.

2.2.2. Extraversion Scales

Six scales from the International Personality Item Pool (n.d.) that assess constructs analogous to the Extraversion facets of the NEO - PI - R Personality Inventory (Costa & McCrae, 2008) have been used to assess Extraversion. These analogous facets are Friendliness (E1), Gregariousness (E2), Assertiveness (E3), Activity Level (E4), Excitement-Seeking (E5), and Cheerfulness (E6). These scales present adequate construct validity statistics: all Pearson's correlation values between the NEO and IPIP scales are >0.95 (IPIP, n.d.).

Since the scales were originally in English, a translation into Spanish was made for this research. The translation prepared for this study has been published in IPIP website and can be publicly accessed.

2.2.3. Measurement of working memory

An online PsyToolkit implementation of a 2-back task (Stoet, 2010, 2017) has been used for the assess of WM. It is a go/no go task in which successions of letters are presented, and subject must press a key when the letter that appears on the screen is the same as two letters ago. In any other case, the subject must not press any key.

Participants received the following visual instructions "You are going to see a succession of letters presented one at a time. If the letter you are looking at is the same as the one you saw two letters ago, press the "M" KEY. If you get it right, you will see two green bars above the letter, and if you got it wrong, they will be red". The visual feedback has been provided whenever the participant issued a response.

Each letter was presented for 2500 milliseconds (inter-stimulus interval of 500 milliseconds). Task consisted of a first practice block and two real blocks of 25 trials, in which both the condition of congruency/incongruency was randomly assigned.

The n - back tasks are a frequently used indicator of working memory and have strong support (Meule, 2017). In this task, three variables were assessed as performance outcomes: *percentage of omissions* (non-detections), *percentage of false alarms* (incorrect detections), and *Reaction Time on Congruent Trials* (milliseconds). This set of variables makes it possible to analyze not only the accuracy of the task (efficacy) but also the time required for participants to issue a response (efficiency).

3. Results

In this section, the results from the correlational analysis are presented first, and they are followed by the analysis of control variables.

3.1. Correlational analysis

Regarding the Spanish ad hoc translation of the scales, all of them presented a Cronbach's alpha value higher than 0.7, so their internal consistency is adequate. The descriptive statistics and a summary of alpha values are presented below, in Table 1.

Secondly, regarding the correlational analysis, Spearman's Rh0 tests were performed, and three significant correlations emerged: E1 (Friendliness) with the percentage of omissions (Rh0 = 0.267; sig. = 0.015), E3 (Assertiveness) with reaction time (RT) (Rh0 = 0.242; sig. = 0,026); and E4 (Activity Level) with RT (Rh0 = 0.256; sig. = 0.019). None of the remaining facets showed any statistically significant correlation with task performance. A summary of Spearman's Rh0 is presented below, in Table 2.

3.2. Control variables

The variable Age correlated significantly with the reaction time in congruent trials (RT) (Rh0 = 0,316; sig. = 0,003). Since facet E4 had also correlated with RT, we tested for a relationship between Age and E4 and found a statistically significant correlation (Rh0 = 0,316; sig. = 0,003). The partial correlation between E4 and RT (controlling for the effect of age) was not statistically significant ($r_{12,3} = 0,146$; sig. = 0,187). We conclude that the correlation between E4 (Activity level) and RT is not statistically significant when the effect of age is controlled.

None of the remaining control variables showed any significant correlations with facets nor working memory performance.

4. Discussion

As explained above, the following statistically significant positive correlations have emerged: between the percentage of omissions in the

Table 1
Descriptive statistics and reliability via Cronbach's α for the six facet-level Extraversion scales.

Facet	N	Mean (s.d.)	Range	α
(E1) Friendliness	87	38,75 (5,19)	26–50	0,774
(E2) Gregariousness	87	32,78 (6,18)	16–47	0,776
(E3) Assertiveness	87	32,09 (5,77)	16–46	0,782
(E4) Activity Level	87	30,93 (5,00)	19–44	0,704
(E5) Excitement Seeking	87	29,13 (5,76)	16–47	0,776
(E6) Cheerfulness	87	37,53 (4,73)	25–48	0.715

Table 2
Summary of Spearman's Rh0 for facets and n-back performance.

Facet		Reaction time	False alarms	Omissions
(E1) Friendliness	<i>RhO</i>	0,072	-0,056	0,22*
	<i>Sig.</i>	0,518	0,608	0,042
(E2) Gregariousness	<i>RhO</i>	0,004	-0,101	0,082
	<i>Sig.</i>	0,972	0,35	0,448
(E3) Assertiveness	<i>RhO</i>	0,242*	-0,133	-0,04
	<i>Sig.</i>	0,026	0,22	0,715
(E4) Activity Level	<i>RhO</i>	0,301*	-0,089	-0,019
	<i>Sig.</i>	0,005	0,413	0,863
(E5) Excitement Seeking	<i>RhO</i>	-0,084	-0,195	-0,024
	<i>Sig.</i>	0,447	0,07	0,823
(E6) Cheerfulness	<i>RhO</i>	0,009	-0,048	0,21
	<i>Sig.</i>	0,938	0,66	0,051

* *sig.* ($p < 0,05$)

n-back task and Friendliness; between the RT and Assertiveness; and between RT and Activity level.

The first correlation means that the friendliest individuals seemed to perform worse in terms of efficacy (higher error rate) than the ones who which scored lower in the facet. The second one means that the most assertive people tended to perform worse not in terms of efficacy, but on efficiency (in terms of higher mean reaction time) compared to the subjects who were less assertive.

Regarding the correlation between Activity level and reaction time, it can't be interpreted as is, since the partial correlation controlling for the effect of age was non statistically significant. The data seemed to show a spurious relation in which age tended to increase the score in Extraversion and in the reaction time separately, so in Spearman's analysis it seemed like both variables were directly related when, in fact, they were not.

As pointed out by the results of the research, the only facets that seem to be related to working memory performance are Friendliness and Assertiveness. According to Campbell and Fiske (1959), if working memory performance is exclusively related to Friendliness and Assertiveness facets, then it means that there is no connection with Extraversion trait, property shared by all indicators, but only with those specific two. This research provides empirical evidence on the need of considering the facets in personality analyses.

A valuable direction for future studies on the matter would be to explore why friendlier and more assertive people tend to perform slightly worse in working memory tasks. A possibility to consider is that their specific neurophysiological underpinnings differ from the ones of the other facets (e.g., less related to DLPFC function). As remarked by Lei et al. (2015), this is an interesting research field that has been very little explored.

5. Open practices statement

This work was formally preregistered before data analysis. The registration can be accessed at this [link](#) and contains the scales employed, the scripts and instructions to replicate the experiment, and the database obtained from the present data collection.

Declaration of competing interest

The author declares no conflicts of interest with respect to the authorship or the publication of this article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.paid.2022.111660>.

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