Comment on “Semantic memory impairment across the schizophrenia continuum: a meta-analysis of category fluency performance” by Tan et al.

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I read with great interest the study by Tan et al. (2020) who conducted a meta-analysis of semantic fluency in people across the psychosis continuum. Among other analyses, the authors provide the first meta-analysis of clustering and switching on semantic fluency in patients with chronic schizophrenia, reporting that patients display significantly smaller “mean cluster sizes” compared to healthy subjects. I argue that there are serious concerns about the compatibility of the clustering data used in the meta-analysis.

The meta-analysis included four clustering studies which, as the authors write, reported the “mean cluster size”. Confusingly, Tan et al. define “mean cluster size” as “number of items reported ÷ number of clusters”. This calculation is in contrast with the most widely used calculation for cluster size suggested by Troyer et al. (1997) who calculate it as: $(N_{\text{clustered words}} - N_{\text{clusters}}) \div N_{\text{switches}}$. It is also unclear what is meant by “number of items reported”. The authors do not use the word “items” in the rest of the main text, while “reported” could suggest that Tan et al. calculated by hand the

“mean cluster size” for the sample from published descriptive data but using a calculation which has not been used in previous literature on psychoses and schizophrenia. In any case, this calculation was not possible in the present meta-analysis because only two of the analyzed studies reported the number of clusters: Berberian et al. (2016) and van Beilen et al. (2004).

Enigmatically, the authors write in Table 1 that “cluster size” was reported in only one study: Bozikas et al. (2005). The other three studies provided the following “performance measures” (as called by the authors): “clustering” (Berberian et al. 2016) and “words per cluster” (Kosmidis et al. 2005; van Beilen et al. 2004). Critically, however, only the variable from van Beilen et al. 2004 was correctly described in Table 1, yet it was not calculated as proposed by Tan et al. (above) but as $N_{\text{clustered words}} \div N_{\text{clusters}}$. On the other hand, Berberian et al. (2016), Bozikas et al. (2005), and Kosmidis et al. (2005) calculated the raw number of clustered words and not “mean cluster size”. Furthermore, Berberian et al. (2016), Bozikas et al. (2005), and Kosmidis et al. (2005) defined clusters as successions of at least *three* semantically related words, while van Beilen et al. (2004) defined clusters as successions of at least *two* semantically related words. The combination of different clustering variables and different thresholds for cluster classification indicates the data were incompatible for a meta-analysis.

Additionally, Berberian et al. (2016) and Bozikas et al. (2005) controlled for total output while comparing the raw number of clustered words between patients and healthy subjects, in order to capture the specific contributions of clustering and switching in the semantic fluency deficits in their samples. While Berberian et al. (2016) reported that there was a significantly smaller number of clustered words in patients even when controlling for total output (yet with a considerably smaller effect when compared to the analysis without the covariate), Bozikas et al. (2005) reported no significant differences. Inferring from data in Table 1, Tan et al. included in their meta-analysis

only the statistics where the total output was *not* controlled, without explicating this for the reader of their paper. It also wonders why the authors included so few clustering studies when, for example, Gabrić & Vandek (2020) non-exhaustively listed 13 clustering studies with patients with schizophrenia (excluding other psychotic disorders) in the introductory part of their paper. Gabrić & Vandek (2020) note that studies that actually calculated the “mean cluster size” (Troyer et al. 1997) found no significant differences between patients and healthy subjects.

Notably, previous research has already emphasized the possible difficulties in performing a meta-analysis of clustering data from verbal fluency tasks. Thiele et al. (2016) reported from their systematic review and meta-analysis of additional performance measures on verbal fluency in patients with traumatic brain injury that 1) different studies analyze different clustering variables, 2) some clustering variables are considerably more sensitive to pathological processes in TBI than others, and 3) different clustering variables may be associated with different aspects of pathological processes. Furthermore, studies with psychiatric patients that analyze different clustering variables tend to report disproportionate associations with psychopathological phenomena (e.g., Weiner et al. 2019). Thus, careful selection and analysis of published data, and, above all, transparency are needed when performing and reporting meta-analyses of clustering data from verbal fluency tasks.

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