Comments on "The relationship between T7-Fz alpha coherence and peak performance in self-paced sports: a meta-analytical review" (Raman, Filho, Exp Brain., 2024): A verbal (analytical) disagreement.

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Dear Editors,

We read with interest the recent publication in Experimental Brain Research by Raman and Filho, where through their meta-analytical review they concluded that "*independent functioning of the motor planning region (Fz) without interference from the verbal-analytical region (T7) is linked with superior sport performance*" and proposed that their findings *"…suggest athletes have reduced verbal analytic processing when performing better on sports tasks".* We welcome the authors' intent, but we disagree with their interpretations and conclusions on multiple levels.

Firstly, it should be acknowledged that the evidence of an association between lower T7-Fz connectivity and superior motor performance is mixed. Indeed, in our systematic review (Parr, Gallicchio, and Wood 2023), we found that only 38% of studies found superior motor performance to be associated with decreased left temporal alpha activity and/or decrease left temporal frontal connectivity. Even specifically in the context of sports, there is evidence that T7-Fz connectivity could not discriminate the superior performance of golf putting (Dyke et al. 2014), hockey passing (van Duijn et al. 2017), or pistol shooting (Hunt et al. 2013). There is also evidence of T7-Fz connectivity tending to increase with practice of a golf task along with performance improvements (Gallicchio, Cooke, and Ring 2017), and evidence that left temporal frontal connectivity was not different between expert and novice rifle shooters despite the experts generally showing lower levels of connectivity across the cortex (Deeny et al. 2009). We would also like to clarify that we believe neither our review, nor Raman and Filho's findings "…*provide evidence that athletes might benefit from neurofeedback training specifically aimed at lowering T7-Fz alpha band coherence".*

Second, the interest on the left temporal (T7) and frontal (Fz) locations stems from the cognitive functions that they purport to represent: respectively, language and motor planning. However, it is crucial to acknowledge that there is sparse evidence to support the very notion that changes in T7-Fz connectivity before or during motor execution specifically reflect changes in verbal-analytic processing. In fact, most studies in this area have not assessed, either directly or indirectly, measures of verbal processing or conscious control. Instead, they often rely on the mere assumption that individuals will reduce their reliance on verbal-analytic processing as they become more skilled (e.g., Fitts and Posner's stages of motor learning; Fitts and Posner 1967)) and increase this reliance when under pressure (Masters and Maxwell 2008). In line with this trend, five of the seven studies analysed by Raman and Filho's review did not include measures of verbal-analytic processing. Also, Gallicchio et al. (2016) found no change in T7-Fz connectivity under conditions of performance pressure, during which verbal-analytic processing is expected to increase. Furthermore, our review (Parr et al. 2023) indicated that T7-Fz connectivity has been unreliably associated with an individual's tendency to engage in verbal-analytic processing, and we have previously provided empirical evidence that encouraging verbal (inner speech) and/or conscious motor processing during a motor skill does not drive changes in T7-Fz connectivity (Parr et al. 2020). Taking the lack of evidence into account, we urge caution on linking diminished T7-Fz connectivity with *"reduced verbal analytic processing when performing better on sports tasks"* as advocated in the meta-analytic review.

Finally, we also disagree that Raman and Filho's findings *"…advance the literature by examining a specific brain pathway (as opposed to "whole brain analysis)"*. Reducing the phenomenon of verbally guided motor control to a single index applicable to a variety of contexts is indeed very appealing. However, that T7-Fz connectivity can be such index is unsubstantiated by evidence. Therefore, limiting research to this index is misguided and might impede rather than promote progress. Our review (Parr et al. 2023) highlighted that

approximately half of studies that undertook more extensive EEG analyses found differences in spectral power and connectivity across various sensor locations and/or frequency bands. If the connectivity effect extends beyond the T7-Fz pair, verbally guided motor control is unlikely the interpretation. On the contrary, it cannot be ruled out that the cortical dynamics underpinning superior motor performance and neural/psychomotor efficiency emerge from a diverse and complex network that cannot be explained through a bivariate, “specific brain pathway”, approach. In this manner, we worry that the continued promotion of T7-Fz connectivity as a unique marker of verbal-analytic processing will encourage the continued adoption of low-resolution EEG approaches (e.g., three channels: T7, Fz, T8), which is problematic for numerous methodological reasons that we have covered previously (Parr et al. 2020, 2023).

Taking these significant limitations into account, in our view a meta-analysis consisting of seven studies is unsuitable to base such a strong and overly simplistic conclusions presented by Raman and Filho. We have said it before, and we will say it again: “there is a need for stronger evidence before left-temporal- frontal alpha connectivity is accepted to uniquely represent such a marker [of verbal-analytical processing]. To strengthen or confute this conclusion, researchers need to employ a more rigorous methodological approach to the collection, pre-processing, analysis and interpretation of data and more research is needed which experimentally manipulates verbally-guided, conscious motor control" (Parr et al. 2023, p.27). Without these stronger methodological and conceptual foundations, we believe it unlikely that that the field will be able to move forward.

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