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## **Notice of Retraction and Replacement. Karalunas et al. Subtyping attention-deficit/hyperactivity disorder using temperament dimensions: toward biologically based nosologic criteria. *JAMA Psychiatry*. 2014;71(9):1015-1024**

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To the Editor

In the Original Investigation titled “Subtyping Attention-Deficit/Hyperactivity Disorder Using Temperament Dimensions: Toward Biologically Based Nosologic Criteria,” published in the September 2014 issue of *JAMA Psychiatry*,<sup>1</sup> there were errors in some cardiac psychophysiology data that prompted a reanalysis of our data. Although the overall conclusions of the article remain unchanged, reanalysis resulted in significant changes to some of the previously reported cardiac psychophysiology findings. Thus, we have requested that our original article be retracted and replaced with a corrected version.

We conducted this study to demonstrate an approach to developing a biologically based nosology for psychopathology using the case of childhood attention-deficit/hyperactivity disorder (ADHD). We studied a group of 437 children with and without ADHD who were participants in an ongoing longitudinal study. Baseline data and mathematical methods were used to classify children into novel subgroups based on temperament dimensions. These profiles were then validated against 3 external criteria: cardiac psychophysiology, magnetic resonance imaging, and future clinical course. Results suggested 3 novel types of ADHD labeled as mild (normative emotion regulation), surgent (extreme levels of positive approach-motivation), and irritable (extreme levels of negative emotionality, anger, and poor soothability). We reported that these 3 types were independent of existing clinical demarcations, including *DSM-5* presentations or symptom severity, showed stability over

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time and were distinguished by distinct patterns of cardiac physiological response, resting-state functional brain connectivity, and clinical outcomes 1 year later.

After publication of our study, a postdoctoral fellow in our laboratory, who was working with the cardiac psychophysiology data for another project, noticed that the methods for artifact detection and removal outlined in the original article had been applied inconsistently. Three of us (S.L.K., E.D.M., J.T.N.) then carefully reviewed and consistently reapplied the originally described methods for artifact detection and removal to all of the raw cardiac psychophysiology data, and S.L.K. rechecked all results. This reanalysis identified changes in statistical significance of some cardiac psychophysiology results for respiratory sinus arrhythmia and the cardiac preejection period (PEP) reactivity. There was no effect on any of the other results, which we have verified; our initial subgrouping, functional magnetic resonance imaging findings, and clinical prediction analyses did not use the cardiac data and so were unaffected.

The reanalysis of corrected data yielded changes in statistical significance of results reported for some PEP (physiological, sympathetic system) findings, requiring corrected parameter values but without altering primary interpretations of the data. Changes in patterns of statistical significance were also identified in respiratory sinus arrhythmia (physiological, parasympathetic) results, and those did alter the interpretation of those findings. Incorporating these changes required corrections in specific sections of the Methods, Results, and Discussion in the article text, Figure 3 of the original article, and eTable 3 in the Supplement.

The numbers of children with data available for cardiac physiological analyses have changed from 178 to 168 children with ADHD and from 128 to 140 children without ADHD (owing to the corrected application of the cleaning algorithms). In the Results section of the article, the  $F$ ,  $P$ , and  $\eta^2$  values for the baseline PEP scores have changed, but the patterns of statistical significance remain the same. The patterns of statistical significance for tonic and reactivity PEP scores have changed such that the group main effect for tonic PEP scores is no longer significant, and there is now a significant main effect of valence. For respiratory sinus arrhythmia reactivity, scores have changed, and the previously reported 3-way interaction is not significant. A follow-up comparison shows that the lack of significance for the 3-way interaction is associated with different group-level patterns in the data than were previously observed.

The Discussion section has been updated to reflect changes in interpretation of respiratory sinus arrhythmia findings. Interpretation of PEP findings remains basically the same. The main conclusions that temperament profiles in children with ADHD are associated with meaningful differences in both central and peripheral nervous system, and longitudinal course remain unchanged but with additional qualification to the peripheral nervous system findings.

We regret any confusion these errors may have caused readers, other researchers, and the editors. We rechecked our original study and updated analyses in detail to ensure there are no other errors. The original article has been corrected, and an online supplement with the

original version of the article with the incorrect information highlighted and a version of the replacement article with the corrections highlighted is available in a new online supplement to the corrected article.

## References

1. Karalunas SL, Fair D, Musser ED, Aykes K, Iyer SP, Nigg JT. Subtyping attention-deficit/hyperactivity disorder using temperament dimensions: toward biologically based nosologic criteria. *JAMA Psychiatry*. 2014;71(9): 1015–1024. [PubMed: 25006969]