Reply to Comments

Wendy Johnson, Andrew Carothers, and Ian J. Deary

Speculation to Inform and Speculation to Explore

Response to Craig et al. (2009) and Turkheimer & Halpern (2009)

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ABSTRACT—Scientific speculation is exploration, but it can also be used to inform, particularly across disciplines. This article, a follow-up to an empirical article on the same subject, was written with both of these purposes in mind. Many researchers are interested in uncovering the genetic mechanisms underlying general intelligence, so no doubt the roles of genes on the *X* chromosome will one day be understood. Psychologists can contribute best to these developments by being informed about the genetic issues involved.

WikiAnswers.com says (as of February 9, 2009) that "[s]cientific speculation is a legitimate part of the scientific process that develops early ideas that are not yet robust enough to be testable, falsifiable or worthy of being more formal 'hypotheses'. Scientific speculations are grounded in established knowledge in a field, but generally go beyond what is defensible. Speculations are not permitted in peer review literature, or are severely limited by editors and peer reviewers. However, speculations can point the way to future research in an area." This is an apt characterization: Though not often allowed in peer review journals, scientific speculation is exploration and is an important way to bring new ideas into a field. But scientific speculation can also inform, particularly across scientific disciplines, as when an introduction to the reasons that scientists in one discipline entertain specific and recurring speculations helps to educate and inform scientists in another discipline about the depth and complexity of the issues in that other discipline.

We wrote this second of a pair of articles with both of these purposes in mind. We thank the editor of this journal for his open mindedness in understanding the importance of introducing psychologists to the genetic information on which speculations about genes associated with general intelligence on the *X* chromosome are based. We thank Craig, Haworth, and Plomin (2009, this issue) for providing, in the same basic journal space, more information than even Ed Diener's tolerance was willing to allow us about the complexities of the genetic mechanisms involved. And we thank Turkheimer and Halpern (2009, this issue) for their thoughtful comments about the social implications of the ideas we raised if those ideas were to be correct. We believe that the field as a whole, awash as it is at present in ideas about genetically determined psychological traits, can only be the better for the kind of more

nuanced understanding of genetics that our article, and the comments it inspired, encourage.

Substantial empirical and historical background (Johnson, Carothers, & Deary, 2008) for the current targeted article was published in the first of our pair of articles in the November 2008 issue of *Perspectives on Psychological Science*. Interested readers may wish to review that article as well. In particular, it provides background details for our statements in this article regarding sex differences in variability at both the high and low ends of the general intelligence distribution.

As Turkheimer and Halpern note, there is nothing inherently wrong with scientific speculation when it is clearly labeled as such. Getting the labeling clear enough can, however, be difficult, as Craig, Haworth, and Plomin have unintentionally demonstrated. They refer in their commentary to four "conclusions" that we reached, suggesting that the question mark in the article's title and the many statements that we were speculating sprinkled throughout the article were still not quite sufficiently clear labels to that effect. We thus wish to emphasize here that the question mark in the title of our article was very intentional: We reached no conclusions about the existence or overrepresentation of genes associated with general intelligence on the *X* chromosome, with the exception that there is enough evidence supporting the possibilities that additional scientific exploration is warranted and the payoffs could be fascinating, whatever their actual content. Much of the material we included, particularly our model of proportions of genes on the *X* chromosome contributing to intelligence, was speculative and relied on assumptions that can best be considered questionable. Can we make the label any clearer?

Craig, Haworth, and Plomin point out that whether sex differences in variability extend to the high end of the distribution of general intelligence is central

to our subject matter. They suggest that the question of mean difference is inevitably important because means and variances are correlated and suggest that higher mean for one sex would imply higher variance and vice versa. There is no doubt that means and variances are often correlated, a point often overlooked, but there is no a priori reason that there could not be two overlapping distributions of general intelligence, one for males and one for females, that have different means but the same variance. Craig, Haworth, and Plomin then go on to suggest that a higher mean and higher variance for males could explain a greater abundance of males at the high end of the distribution but not at the low end. This is not necessarily true: If a variance difference were large enough, it certainly could explain male overrepresentation at the high end of the distribution. Moreover, it could explain even equal degrees of male overrepresentation at each end or greater male overrepresentation at the low end. These could easily take place if, for example, the distribution of general intelligence were asymmetrical in either or both sexes. As we demonstrated in our previous article on this subject (Johnson, Carothers, & Deary, 2008), there is ample evidence that, in fact, the distribution of general intelligence is not symmetrical—it bulges at the lower end.

Turkheimer and Halpern remind us all that science does tend to proceed without a large amount of formal discussion of the potential consequences of the information uncovered, though it has not been completely absent (e.g., Nuffield Council on Bioethics, 2002). Many researchers are already actively engaged in pursuing the genetic mechanisms underlying general intelligence. No doubt we will eventually understand how and to what degree genes, whether located on the *X* chromosome or not, contribute to general intelligence and to sex differences in its manifestation. We hope that our targeted article and the comments it inspired will

help psychologists to recognize how unlikely it is that the explanation will turn out to involve deterministic one-to-one gene–trait correspondences. At the same time, as humans we remain the products of our evolutionary history. To disregard that history is to abandon scientific principles in favor of political correctness or wishful thinking.

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