Response to Davis and Plaisted-Grant:

Psychophysical data do not support the low noise account of autism

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Davis and Plaisted-Grant's (2014) interesting new theory posits that atypical perception in autism can be attributed to reduced levels of noise in small-scale neural networks. This account is controversial as other authors have suggested instead that individuals with autism have *elevated* levels of neural noise (e.g., Simmons et al., 2009). Indeed, Davis and Plaisted-Grant's account raises the important point that both having "too much" or "too little" neural noise could have significant consequences on perceptual development. However, the only way to resolve these conflicting accounts is through experiments that clearly target the actions of noise. While Davis and Plaisted-Grant propose three consequences of low neural noise, here we focus on just one: the influence of internal noise on detection and discrimination thresholds. We review both the authors' and our own data and suggest that current psychophysical evidence cannot be accounted for by low neural noise in autism.

A recent empirical study by Greenaway, Davis and Plaisted-Grant (2013) found a small but significant increase in contrast discrimination thresholds in autism for a 'steady pedestal' task intended to target the magnocellular system. Although they argue that this result is due to decreased internal noise, this explanation is at odds with current thinking on the neural processes underlying contrast discrimination performance. Models assuming a nonlinear transducer and additive internal noise predict that thresholds should rise when internal noise levels increase, just as Greenaway et al. found (see Baker, 2013, for model simulations). An alternative view is that transduction is linear, but that multiplicative (signal-dependent) noise causes thresholds to increase with pedestal contrast. Under this account, increased thresholds are again consistent with greater internal noise.

The low-noise account appeals to stochastic resonance processes, whereby performance can be improved by the addition of low levels of external noise (see Simmons et al., 2009). Yet as the authors themselves concede, evidence for these effects at the psychophysical level is highly contentious, as most studies cannot dissociate true stochastic resonance effects from uncertainty reduction due to spatio-temporal co-presentation of target and noise mask. A more serious problem with stochastic resonance effects is that they should occur for both neurotypical individuals and individuals with autism, albeit at different levels of external noise (corresponding to their differing levels of internal noise). It is unclear why the authors believe that stochastic resonance would aid one group more than the other, and without predictions from explicit computational models these accounts remain difficult to test.

Davis and Plaisted-Grant suggest that low neural noise may explain previous reports of reduced sensitivity to coherent motion by individuals with autism, in a task where observers are required to determine the direction of coherently moving dots amongst randomly moving dots. They suggest that individuals with autism may perceive the direction of each dot with increased clarity and distinctiveness due to an increased signal-to-noise ratio, which in turn reduces integration of individual dot motions in these stimuli. Yet, recent data suggest that the integration of motion signals is in fact *enhanced* in individuals with autism (Manning et al., 2014). In Manning et al.'s study, children with autism and age- and ability-matched typical children were asked to report the average direction of dots sampled from a continuous distribution, and it was found that children with autism could compute the average dot direction over a *wider* range of directional variability than their typically developing peers. While these results may arise from reduced noise in the integration process in children with autism, Davis and Plaisted-Grant's theory specifically argues that reduced noise is local in nature. The low noise theory therefore does not provide a good account of these data.

Commendably, Davis and Plaisted-Grant aim to establish a theory that is as easy to falsify as possible. In particular, they state that the effects of low neural noise should be evident in cognitive and perceptual performance. Yet, we suggest that at least two sets of existing psychophysical data speak against this theory. Furthermore, sophisticated psychophysical techniques exist which could be used to estimate internal noise directly, such as double-pass detection-in-noise methods which provide a measure of the ratio of internal:external noise. Future research efforts must focus on combining such psychophysical measures with neurophysiological techniques, to determine explicitly how atypical levels of noise may lead to atypical perceptual performance in individuals with autism.

References

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