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Invited reply

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Rescuing the baby from the bathwater: a reply to Carter (2013)

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Carter [1] identifies putative conceptual and methodological flaws in a paper from our laboratory on the effects of the social environment on exploration–avoidance behaviour in a cichlid fish [2]. Although we welcome discussion of methodological issues that fosters the use of more solid experimental designs in personality research and we acknowledge that the experimental design used can be further improved, we disagree that the issues raised call into question the main conclusions of the target paper. Below, we reply to the problems identified by the author.

Problem 1: what is the validity of the exploration/neophobia measures used?

First, the author interprets the reported lack of consistency of the exploration/neophobia results across different social contexts as indicative of lack of validity within a single context. Although we fully agree that within-context behavioural consistency (i.e. repeatability) is central to the definition of personality and to the validity of any personality test, we do not see how the lack of consistency across contexts can be interpreted *per se* as indicative of lack of consistency within-contexts and therefore question the validity of the novel object (NO) test used. Given that the social context has been manipulated in the target paper [2], we consider that the most parsimonious explanation (but not necessarily the correct one) for the lack of across-contexts consistency is that the manipulation of the independent variable (social context) induced the variation in the dependent variable (exploration/neophobia) in a differential way and that this caused the interaction effect that the lack of correlations across social contexts suggests. In our view, only the measurement of within-context consistency could clarify the point raised by the author, which unfortunately was not measured in the original study [2], based on the assumption of NO tests having high repeatability. This assumption was based on the wide use of the NO test in animal personality research and on available data for other cichlid species [3] that suggests a high within-context consistency of NO test measures in the short-term for this taxon. Thus, it is this assumption (and not the lack of between context consistency) that should be questioned, and in this regard we second Carter's view that within-context consistency should always be verified in animal personality studies. This is certainly an aspect to improve in future studies.

Second, the author claims that novelty, a key aspect of the face validity of any exploration–avoidance test, is compromised, because the animals were exposed three times to the same NO, suggesting that a more appropriate procedure would have been the use of different objects in successive NO exposures. Indeed, this is a common procedure in animal personality research [3]. However, this procedure raises other methodological problems that are seldom discussed and that have to do with the need to control for variation in the valence and salience of the NOs used and their functional value to the

animals [4]. Therefore, both repeated exposures to the same NO and the use of different NOs across trials raise methodological issues that have to be dealt with, and *a priori*, one procedure cannot necessarily be considered more correct than the other. In order to deal with the potential bias induced by the repeated use of the same NO, the following measures were taken in the original paper: (i) tests were spaced in time (7 days apart) in order to minimize habituation; (ii) a short test duration (10 min) was used in order to reduce the salience of the NO; and (iii) the order of the tests was balanced in order to distribute any remaining habituation effect across treatments. Furthermore, *a posteriori*, it was confirmed that the order of exposure to the NO had no effect on the behaviours of interest (Friedman tests: exploration of the NO, $\chi^2 = 0.42$, $p = 0.81$; time spent close to the NO, $\chi^2 = 0.73$, $p = 0.70$; time freezing, $\chi^2 = 1.50$, $p = 0.47$). Thus, no evidence of habituation to the NO was found.

Problem 2: lack of appropriate controls

We acknowledge that the fact that only the females of one of the treatments were manipulated may raise reasonable doubts about the interpretation of our results, and therefore we explain below in more detail the rationale for this manipulation, how to improve it, and why we do not think that it had an impact on our results. We opted for the replacement of females only 1 h before the test in the unfamiliar treatment to avoid a potential effect of habituation to an unfamiliar female during the 4 days of acclimatization that the focal males spent in the presence of the stimulus females. An improvement in future studies to control for the potential confounding effects of the manipulation of the stimulus female in the unfamiliar treatment would be to manipulate also the familiar females by also removing and placing them back in the same tanks 1 h before the test. However, the fact that only the unfamiliar females were manipulated seems not to have had a differential effect on the behaviour of the focal males owing to a decrease in their activity in response to the disturbance (as proposed by Carter [1]), because no differences were found between social contexts in swimming activity (Friedman test: $\chi^2 = 0.73$, $p = 0.70$) or in any other variables that could indicate a differential interest in the stimulus female by the focal male owing to the 'disturbance' (i.e. no difference between familiar and unfamiliar female treatments in time spent near the female's aquarium and in the frequency of touches in it; see results section of the target paper). Again, although there is room for improvement of the experimental design, the issue raised by the author did not compromise the interpretation of the results obtained.

In conclusion, the conceptual and methodological issues raised can and should be improved in future studies, but, in our opinion, these concerns do not undermine the validity and main conclusion of the target paper.

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