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Christian Gerlach, Cathrine Heikamp Lissau & Nanna Kirkegaard Hildebrandt

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COMMENTARY

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On defining and interpreting dissociations

Christian Gerlach [a], Cathrine Heikamp Lissau[b] and Nanna Kirkegaard Hildebrandt[b]

[a]Department of Psychology, University of Southern Denmark, Odense, Denmark; [b]Department of Psychology, University of Copenhagen, Copenhagen, Denmark

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A common assumption in cognitive neuropsychology is that a single (classical) dissociation will trump any accounts suggesting totally shared mechanisms, and this no matter how many observations of associations can be mustered (see e.g., Tree, 2011). Due to this special status of dissociations it seems reasonable to demand, as Geskin and Behrmann do (this issue), that dissociations between face and object recognition in developmental prosopagnosia (DP) must be demonstrated taking into account both accuracy and latency (RT), and these demonstrations ought to rest on data from assessments of face and non-face recognition that are matched in complexity and processing demands. Even though the latter condition may be hard to fulfil in reality (Robotham & Starrfelt, 2017), it is nevertheless the case that a dissociation demonstrated by contrasting performance on, for example, a difficult face recognition task and an easy object recognition task may reflect nothing besides a difference in task difficulty.

A methodological issue not considered in great detail by Geskin and Behrmann, however, is how a dissociation is defined. They seem to adopt the common definition that a dissociation is established if a person performs abnormally on task *X* but within the normal range on task *Y*, with 'normality' being anchored by whether performance falls below or beyond 2 SDs (or 1.7) of the control mean. There are two problems with this approach. First, it implicitly assumes that failure to reject the null hypothesis regarding performance on task *Y* is proof of normality. This is a dubious assumption (Crawford, Garthwaite, & Gray, 2003), not least because studies in cognitive neuropsychology are typically characterized by low statistical power (few controls) which leaves plenty of room for Type 2 errors (false-negatives). Secondly, it does not take into consideration the difference in performance between tasks *X* and *Y*. In the extreme case, one could claim a dissociation if a person's scores amounted to −2.01 SD on task *X* and −1.99 SD on task *Y*; a trivial difference of .02 SD. To overcome these problems, Crawford et al. (2003) have suggested that a performance pattern must fulfil two criteria in order to be considered as a dissociation: 1) the person's performance on task *X* must differ significantly from that of the normal population; and 2) the difference in performance of that person on tasks *X* and *Y* must differ significantly from the difference scores of the normal population on tasks *X* and *Y*.

Crawford et al. have even developed computer programmes which can be used to assess whether a particular performance pattern qualifies as a dissociation when both criteria are taken into account (Crawford, Garthwaite, & Porter, 2010). In addition to testing whether a case's scores on tasks *X* and *Y* differ significantly from the normal population by using the control participants' mean and SD as sample statistics (rather than as population parameters), these tests estimate whether the case's standardized difference between tasks *X* and *Y* differs significantly from the standardized differences in controls by taking into account the correlation between tasks *X* and *Y* in the control sample. If a dissociation is revealed, it may be either a strong dissociation or a putatively classical dissociation (Shallice, 1988). A strong dissociation refers to a performance pattern where an individual's scores deviate significantly from the control sample on both tasks *X* and *Y*, and where the individual's difference between tasks *X* and *Y* exceeds what can be expected in the normal population. In comparison, a

CONTACT Christian Gerlach cgerlach@health.sdu.dk

putatively classical dissociation refers to a performance pattern where an individual's scores deviate significantly from the control sample on one of the tasks but is within the normal range on the other, and where the individual's performance difference between tasks *X* and *Y* exceeds what can be expected in the normal population. The reason why the classical dissociation is termed '"putative' is that failure to reject the null hypothesis for one of the tasks does not really constitute evidence of normal performance on that task. As mentioned above, failure to reject the null hypothesis might for example reflect low power or the use of an insensitive test.

The importance of task correlations

As argued above it is important that dissociations be based on positive evidence, i.e., that an individual's performance on task *X*, in addition to being outside the normal range, also differs significantly from the same individual's performance on task *Y*. It is only under this more stringent definition that two of the DPs that we have reported (PP07 & PP27) fail to show a dissociation between face and object recognition performance (Gerlach, Klargaard, & Starrfelt, 2016). Had they been classified according to the common definition they should have been listed in Appendix 3 (normal object recognition based on both accuracy and RT data) rather than in Appendix 5 (definite object recognition impairment) where they appear in Geskin and Behrmann's review. In other words, the only reason that PP07 and PP27 do not count as dissociations (under the stringent definition) is because the differences they exhibit between face recognition and object recognition are not (significantly) larger than what can be expected in the normal population. This latter aspect, however, can only be assessed if we know the correlation between tasks *X* and *Y* in the normal population, but this information is seldom available for neuropsychological tests. Alternatively, one can estimate the correlation based on the control sample, but this requires that the control sample is the same for tasks *X* and *Y* which is often not the case. Of the 'Category 3' studies listed by Geskin and Behrmann, only the study by Dobel, Bolte, Aicher, and Schweinberger (2007) reports the information necessary to perform these analyses for comparable tasks (Table 6, Dobel et al., 2007), and these analyses yield no evidence for a dissociation, neither classical nor strong.

Provided that a correlation between tasks *X* and *Y* can be estimated, it also becomes easier to assess how interesting a dissociation is. Intuitively, the higher the correlation between tasks *X* and *Y* is in the normal population the more surprising it will be to find a case where performances on these tasks dissociate. Also, if task correlations can be estimated, the following issues which arise in Geskin and Behrmann's review can be tackled.

The first is concerned with what weight should be given to a (putatively) classical dissociation. Taken at face value, Geskin and Behrmann have identified not less than 47/238 (category 3/category $3 + 4 + 5$) cases exhibiting a classical dissociation between face and object recognition. Nevertheless, they still seem reluctant to conclude that the impairment in DP can be face-specific. The reason for this is presumably that: "If the single case came from Category 4 or 5, however, we would have concluded that both face and object recognition were deficient and sometimes severely and equally so. Clearly, reaching conclusions from a single case would have been misleading." (Geskin and Behrmann). This, however, is not a strong argument. If a dissociation is valid for a single case, then it does not matter how many other cases may fall into other categories; or at least that is the traditional stance in cognitive neuropsychology. Having said this, Geskin and Behrmann point to another issue which concerns the validity of these 47 cases. What if the dissociations exhibited in these cases just reflect individual differences? We will argue that this possibility provides another good reason for taking into account task correlations in the normal population. Only when we know the variability of individual differences on each task, and how they relate, can we minimize the possibility that a dissociation reflects normal variation in the abilities tapped by the two tasks; a point we exemplify below.

In their survey Geskin and Behrmann distinguish between DPs according to whether they score below 2 SDs (Category 5) or between 1.7 and 2 SDs (Category 4) on measures of object recognition. In one respect this procedure seems justified. As argued above, failure to reject the null hypothesis is not 'proof' of normality. Accordingly, adopting a criterion of 1.7 SD is the more safe play if one seeks to reduce the risk of making a type II error. However, from the discussion above it should be clear that this partitioning according to *Z*-scores is somewhat arbitrary unless the task correlation in the normal population is taken into consideration. This is best illustrated with a couple of examples. Imagine a scenario *A* where: 1) the mean of the controls ($N = 25$) is 12 on task *X* (SD = 3) and 9 on task *Y* (SD = 3), and where $r_{XY} = .1$; and 2) the scores of a DP are 3 on both tasks *X* and *Y*. In this scenario the case would not fulfil the criteria for a classical/strong dissociation according to Crawford et al. (2003); yielding *Z*-scores of −3 and −2 on tasks *X* and *Y*, respectively. Imagine now a scenario *B* which only differs from scenario *A* in that the DP now scores 3 on task *X* and 4 on task *Y* yielding *Z*-scores of −3 and −1.7, respectively. In this scenario the case would still not fulfil the criteria for a classical/strong dissociation. Imagine now that we change scenarios *A* and *B* so that r_{XY} changes from .1 to .85 but all other values stay the same. In these cases, scenario *A* will still not amount to a dissociation whereas scenario *B* will amount to a (putatively) classical dissociation. The point is that without knowledge of how performance across two tasks relate, direct comparison of *Z*-scores associated with the tasks does not tell us much.

Classical vs strong dissociations

Our final comment concerns types of dissociations. From a clinical point of view it may not matter much whether an individual with a face recognition deficit has a subtle impairment in visual object recognition (strong dissociation) or not (classical dissociation). However, from a theoretical perceptive the distinction is important. A classical dissociation would suggest a qualitative difference in the kind of operations that face and object processing call for. In comparison, a strong dissociation would lend itself more naturally to interpretations regarding quantitative differences between the two domains, e.g., in visual similarity or visual complexity of their members, or between the tasks used, e.g., in the demand they place on perceptual differentiation. Differences in perceptual differentiation and visual similarity are known to yield different patterns of category effects in visual object recognition (Gerlach, 2017a, 2017b). In this sense, a strong dissociation suggests both a (quantitative) difference and an association. A case may be impaired with both faces and objects because both domains tax process *X* (association), which is compromised, but faces may do so more than objects (dissociation). For this reason, it is unfortunate that Geskin and Behrmann seem to dismiss the distinction between classical and strong dissociations, arguing that it is almost impossible to adjudicate between them; and it is not clear why they think so. Presumably it has something to do with difficulties '… in measuring face and object recognition on a level playing field' (Geskin and Behrmann). This difficulty, however, does not seem specific to dissociations but also applies to associations just the other way around. Where a dissociation between two tasks is more surprising/interesting the more comparable the two tasks are, an association between two tasks is more surprising/interesting the more the tasks differ.

Conclusion

Geskin and Behrmann have identified several limitations in the current literature on DP. In addition to these, we have argued for the necessity of applying more stringent criteria/methods for defining dissociations. As far as we can tell, none of the studies listed in Geskin and Behrmann's review reports dissociations in face and object processing which are free of these weaknesses. This severely limits the conclusions that can be drawn from these studies regarding processing differences between these domains. However, if future studies can address these limitations, studies of DP may prove valuable to the understanding of face recognition and its development.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Christian Gerlach http://orcid.org/0000-0003-1261-4889

References

Crawford, J. R., Garthwaite, P. H., & Gray, C. D. (2003). Wanted: Fully operational definitions of dissociations in single-case studies. *Cortex*, *39*(2), 357–370.

Crawford, J. R., Garthwaite, P. H., & Porter, S. (2010). Point and interval estimates of effect sizes for the case-controls design in neuropsychology: Rationale, methods, implementations, and proposed reporting standards. *Cognitive Neuropsychology*, *27*(3), 245–260. doi:10.1080/02643294.2010.513967

Dobel, C., Bolte, J., Aicher, M., & Schweinberger, S. R. (2007). Prosopagnosia without apparent cause: Overview and diagnosis of six cases. *Cortex*, *43*(6), 718–733.

Gerlach, C. (2017a). Different measures of structural similarity tap different aspects of visual object processing. *Frontiers in Psychology*, *8*, 1404. doi:10.3389/fpsyg.2017.01404

Gerlach, C. (2017b). Normal and abnormal category-effects in visual object recognition: A legacy of Glyn W. Humphreys. *Visual Cognition*, *25*(1-3), 60–78. doi:10.1080/13506285.2016.1258022

Gerlach, C., Klargaard, S. K., & Starrfelt, R. (2016). On the relation between face and object recognition in developmental prosopagnosia: No dissociation but a systematic association. *PLoS One*, *11*(10), e0165561. doi:10.1371/journal.pone.0165561

Robotham, R. J., & Starrfelt, R. (2017). Face and word recognition can be selectively affected by brain injury or developmental disorders. *Frontiers in Psychology*, *8*(1547). doi:10.3389/fpsyg.2017.01547

Shallice, T. (1988). *From neuropsychology to mental structure*. Cambridge: Cambridge University Press.

Tree, J. J. (2011). Mental imagery in congenital prosopagnosia: A reply to Grüter et al. *Cortex*, *47*, 514–518.