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Viewpoint

Grey matter or social matters? Causal attributions in the era of biological psychiatry

Health policy makers predict that, ultimately, new diagnostics will likely redefine any "mental disorder" as a "brain circuit disorder" [1,p.499]. Such exclusive reductionism not only neglects the sociocultural side of neuropsychiatric disease [2], but is also based on unjustified causal attribution. In view of the correlative nature of most neuroimaging studies, such unidirectional interpretation might be grounded in the "neuroseductive" appeal of brain images [2]. This might have important consequences as it is likely to facilitate the transition of a lifestyle condition to a disease once some neural correlate has been uncovered. Here, we used the example of xenomelia to investigate and illustrate the perception and interpretation of correlations in the field of biological psychiatry.

Xenomelia (from Greek xeno = foreign and melos = limb) designates the pervasive and persistent feeling that one or more of one's limbs does not belong to one's bodily self. Xenomelia is accompanied by the conviction that only an amputation would bring about relief. On grounds of its frequent association with an individual's erotic life, it had long been considered a paraphilia, but was re-interpreted as an identity disorder (BIID, for "body integrity identity disorder" [3]). As such it would comprise, apart from the desire for amputation, the more general longing for a physical disability. Only more recently, xenomelia has attracted the spotlight of neuroscientific enquiry [4; 5 for review] and ever since studies aiming to determine biological substrates have been on the increase.

We were specifically interested in investigating the causal attribution from correlations in individuals who received third-level education. They should be sensitized to such logical fallacies, since the distinction between correlation and causality is being addressed across the whole range of academic subjects. But when it comes to gut decisions about a potentially stigmatizing condition, how much do we judge the brain to be responsible for the particular behaviour?

In order to gain insight in persons' causal inferences in the face of correlational evidence, we set out to investigate European academics' interpretation of a visually depicted correlation from the first structural neuroimaging study on xenomelia. The correlation shows an inverse relation between the strength of a xenomelic individual's amputation desire as measured by a questionnaire and the size of a circumscribed surface area of parietal cortex (n = 13 men with xenomelia; [6], see Fig. 1A and B). We were interested in the balance of any causal inferences from this correlation, i.e. how plausible the primacy of brain-over-behaviour (amputation desires caused by altered neural structure) would be judged compared to that from behaviour-to-brain (structural brain alterations caused by amputation desire). We further explored whether the preference for one primacy type over the other depended on a participant's academic training, with respect to a trainee's potential role in a medical or neuroscience-related occupation.

An online survey was programmed and hosted on the LimeSurvey Software Version 2.0+ (Germany). The link to the survey was sent to members of European academic communities representing different fields for further distribution. After providing informed consent, participants read a brief text describing the clinical picture of xenomelia. This text was accompanied by a scattergram depicting the correlation mentioned above (Fig. 1A) alongside the display of an inflated right hemisphere showing the location of the cortical area involved (Fig. 1B). Participants were asked to rate, on the basis of the described finding, the plausibility of each of two statements by placing a slider on a line between 0 (maximally implausible) and 100 (maximally plausible). The statements read "Changes in the brain may produce changes in the acceptance of one's limbs" and, respectively, "Changes in the acceptance of one's limbs may produce changes in the brain". Presentation order of the two statements was randomized across participants.

In total, 769 participants from a European country, who were at least 18 years old, answered the survey. As we were interested in causal attributions of individuals with third-level education, we only included the 631 participants who either held a university degree (n = 381, mean age = 38.89, 200 women) or were studying to obtain one (n = 250, mean age = 26.46, 175 women). Fig. 1C contrasts the plausibility ratings of two groups with a different academic background (medicine, psychology, or neuroscience; n = 380, mean age = 32.0 years, 258 women, or arts, law, economy, or natural sciences other than neuroscience, n = 251, mean age = 37.0 years, 117 women). We refer to the participants of group 1 as "potential medical specialists" and the participants of group 2 as "unlikely medical specialists". Nonparametric tests were used as the plausibility ratings were not normally distributed. A Wilcoxon signed rank test revealed that, over both groups, neural primacy (NP) was rated more

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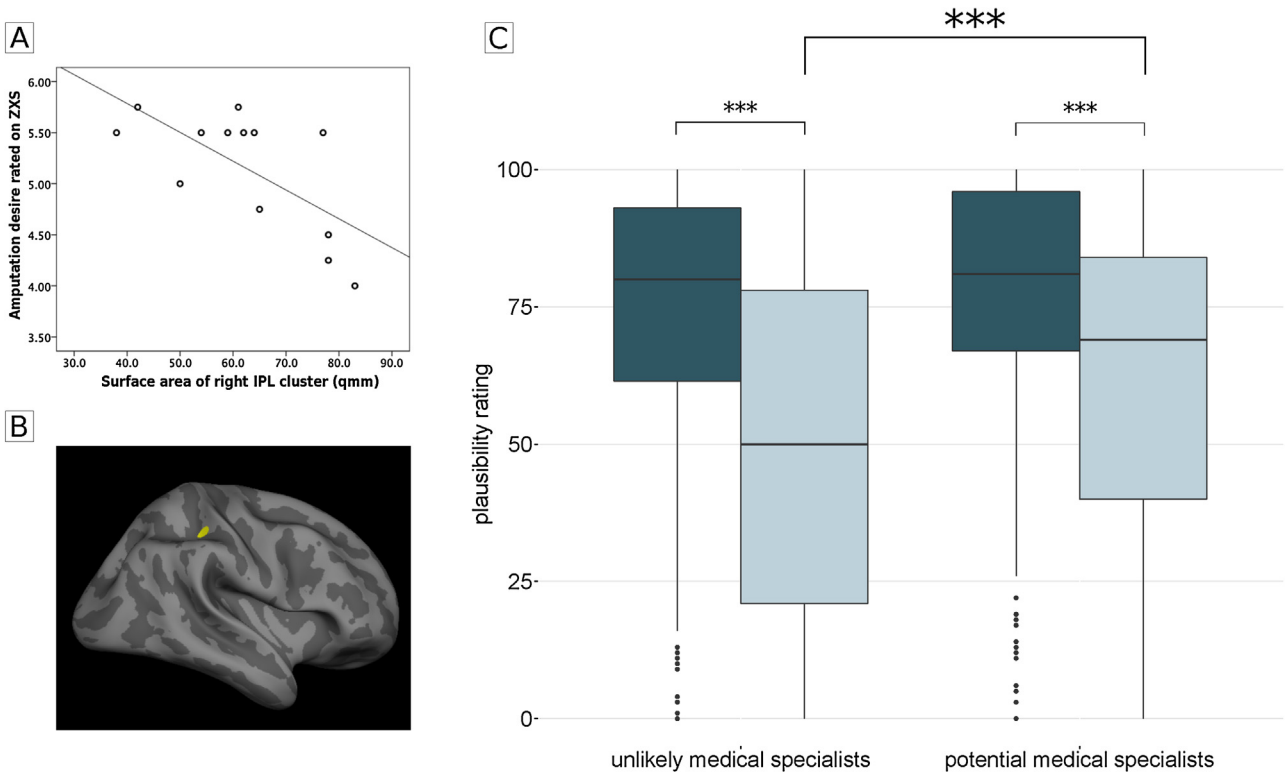

Fig. 1. Correlation between the strength of an individual's amputation desire and the surface area of a circumscribed region in the inferior parietal lobe (depicted in B). C: Box-and-whisker plots show distributions of plausibility ratings for two types of causality arguably implied by this correlation, i.e. neural primacy (dark bars) or behavioural primacy (light bars). A and B reprinted, (with permission), from ref. [6].

plausible than behavioural primacy (BP; $Z = -12.17$, $p < 0.001$; $\eta 2 = 0.24$). Two separate Mann-Whitney tests showed that NP was comparable between the two groups ($Z = -1.14$, $p = 0.28$; $\eta 2 = 0.002$), whereas the plausibility of BP was rated higher by the potential medical specialists ($Z = -4.42$, $p < 0.001$; $\eta 2 = 0.03$). Neither gender nor age influenced the plausibility ratings significantly (correlation gender and NP: $r = 0.068$, $p = 0.085$; gender and BP: $r = -0.01$, $p = 0.794$, age and NP: $r = -0.035$, $p = 0.377$, age and BP: $r = -0.019$, $p = 0.617$).

Together, these findings confirm that, in making causal inferences about brain-behaviour correlations, "the vector of causality is unidirectional: from brain to mind" [7,p. 502], even in academia. The inference of causality regarding the symptoms in conditions such as xenomelia has wide-ranging societal implications [8]. Access to and nature of care will heavily depend on the emerging definitions of such conditions. Fortunately, those whose training prepares them to work in the medical or neuroscientific sector seem slightly less inclined to put grey matter before social matters. There is thus hope that the social and cultural components of xenomelia as well as other conditions in a similar situation will not be underestimated [5].

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