GSCs (which was our main concern in the target paper).

A second sense in which consciousness might be said to come in degrees concerns state consciousness. A mental state is conscious when it makes a contribution to the individual's experiential perspective. Some mental states (e.g., those that occupy the focus of attention) clearly make such a contribution. Other mental states (e.g., the subpersonal information-processing representations involved in speech recognition) make no such contribution. A natural reading of the claim that state consciousness comes in degrees is that some mental states make more of a contribution to an individual's experiential perspective than others. Is this what Fazekas and Overgaard mean by degrees of consciousness?

Apparently not, for they say that 'degrees of consciousness' refers to 'the quality of the individual's experience of a given stimulus'. In explicating this idea, they point out that perceptual experience can be degraded in various ways. Stimuli that are presented in low-contrast conditions might be experienced only faintly and with little precision. These claims are surely incontestable and we did not mean to deny them. What is less clear is why these facets of perceptual experience should be conceptualized as variation in degrees of state consciousness rather than in terms of variations in the contents of consciousness. Consider the fact that maps can differ in their informational content (e.g., in how detailed they are) without differing in the degree to which they are 'maplike' (whatever that might mean). Why should not an analogous point hold with respect to perceptual experience? In other words, we suggest that experiences can differ in the quality of their information content without differing in how 'experiential' they are.

The phrase 'degrees of consciousness' is a semitechnical term and theorists are at liberty to use it as they please, but in our view it is unhelpful to describe changes in the quality of experience as changes in degrees of consciousness. We already have an adequate vocabulary for describing changes in the contents of experience, and to describe such changes as changes in degrees of consciousness invites confusion.

Let us return to the suggestion that our multidimensional analysis of GSCs rules out any possible role for degrees of consciousness in their analysis. In making that claim we were concerned with the two conceptions of degrees of consciousness that we outlined earlier, and we did not mean to deny that degrees of consciousness in the sense in which Fazekas and Overgaard use that phrase should play a role in the analysis of GSCs. Although we do not think that models of GSCs ought to take the quality of experience as their 'point of departure' (as Fazekas and Overgaard put it), we do agree that this feature of consciousness should inform models of GSCs. Indeed, in discussing the content-based dimension of GSCs, we pointed out that the contrast between various GSCs is likely to involve changes in the specificity with which individuals are able to represent objects. In sum, we deny that changes in the determinacy, intensity, and precision of conscious contents qualify as changes in degrees of consciousness, but we do not deny that such changes are relevant to models of GSCs – indeed, we insist on it.

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Spotlight

Judging the Ability of Friends and Foes

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Collaboration leads us to judge our own ability to be more similar to our collaborators and their ability to be more similar to our own, while competition leads us to exaggerate the gap between our abilities. How does this happen and what does it mean?

As a social species, humans are continually tracking the states of our conspecifics. We monitor states of knowledge, emotion, and physical condition to better predict and control our interactions with others and to learn about our physical and social environment. Representation of others also allows information to be garnered about the self; knowledge of my previous attempts to run 100 m enables me to predict how long it will take the next time I do so but does not enable me to answer the question 'Am I fast?'; only comparison with others allows us to answer such relational questions.

Representation of others introduces a requirement to keep self- and other-related representations distinct. For example, if I am preparing to return your tennis serve I need to form as complete a representation of your action as possible to predict the flight of the ball but keep the representation of your action distinct from the representation of my motor plan to return the ball [1]. A similar 'self–other distinction' is necessary when attempting to adopt the perspective of others or to represent their emotions or attitudes, especially when they are in conflict with one's own [1]. Interestingly, the degree to which a self–other distinction is maintained can be impacted by task demands and social factors. Although we tend to imitate individuals from our ingroup more than from outgroups (a result of blurring the distinction between self and other for ingroup members), this tendency can be nullified, or even reversed, when our aim is to engender cooperation with outgroup members and to compete with ingroup members [2].

A recent paper made important contributions to our understanding of self–other distinction by demonstrating that judgments of our own ability can be influenced by our judgments of the ability of others and that this influence is modulated by the context within which such judgments occur. Wittmann and colleagues [3] demonstrated that, when asked to judge their own performance on a task, participants' judgments were influenced by their judgments of others in a context-dependent fashion. Specifically, when participants chose to collaborate with another individual they judged their ability to be more similar to that of the other, but when they decided to compete with the other they judged their ability to be further from that of the other. Judgments concerning the ability of the other were also influenced by judgment of the self in a complementary fashion. This finding is reminiscent of previous findings within social psychology that cooperative attitudes promote attention to similarities between group members whereas competitive attitudes promote attention to differences between group members [4], but extends these findings to demonstrate that cooperation versus competition can influence judgments themselves, not just whether those judgments are attended to.

Wittmann and colleagues [3] used fMRI to identify neural correlates of their behavioural effect. A model-based analysis revealed that representation of one's own ability was associated with activity in the perigenual anterior cingulate cortex, whereas activity in dorsomedial frontal area 9 tracked the other's ability, and also likely integrated self- and other-related information according to context. It is likely that the temporoparietal junction is then involved in selecting whether self or other is attended to [5,6]. Although these results indicate a potential neural mechanism by which representations of the self and other may interact, the psychological mechanisms are less well understood. While not the focus of the paper, the authors did note that their results are consistent with the 'anchoring' effect [7] whereby individuals produce biased estimates of uncertain values because they base or 'anchor' their estimates on an initial value. For example, imagine that two groups are presented with a new piece of technology and asked to estimate its value. If one group is told that the technology had been reduced from £100 and the other that it had been previously reduced to £50, the former group is likely to assign it a higher value. The suggested explanation is that the values assigned by the groups are anchored by the values of £100 and £50, respectively, and that participants tend not to move too far from these values. When judging their own ability and that of the other, participants in Wittmann and colleagues' experiment may focus on the difference between abilities when they are asked to compete and on the average of their abilities when asked to collaborate; the difference between these values biases their estimates of their own ability and that of the other according to context.

The anchoring explanation raises important questions about the domain generality of effects such as those observed by Wittmann and colleagues. Future studies may build on their findings by investigating whether comparable effects are observed if participants are asked to estimate the performance of an algorithm or robot instead of another human. A non-social control condition [6,8] such as this would clarify the extent to which such effects can be described as social in nature and identify whether they reflect the degree of distinction between self and other representations specifically or whether they might be obtained via the same mechanism that produces anchoring effects in non-social contexts. This question is not merely of academic interest; failures of self–other distinction and selective representation of self or others are thought to characterise some clinical groups, such as those with autism [9], while studies suggest that self–other processing is likely to be still developing into adulthood [10]. If judgments of our own ability also fit into the same framework, this may underlie the difficulties with interpersonal coordination during joint tasks experienced by some clinical populations and the atypical risk behaviour exhibited by adolescents, particularly in social situations. The latter possibility is consistent with the high accident rate among teenage drivers when they are with their peers: teens may overestimate their degree of control at high speeds and put themselves in danger. It is therefore interesting that the ability to selectively represent self and other can be modulated by brain stimulation, providing the potential for intervention should this prove necessary [5].

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Spotlight

What Type of Awareness Does Binocular Rivalry Assess?

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Recent experiments demonstrate that invisible stimulus features can induce binocular rivalry, indicating the phenomenon may be caused by differences in perceptual signal strength rather than conscious selection processes. Here, we clarify binocular rivalry's role in consciousness research by highlighting a critical difference between two distinct types of visual awareness.

Among neuroscience researchers interested in determining the neural correlates of consciousness, binocular rivalry has been heralded as a gold standard since Crick and Koch's endorsement of the paradigm [1]. In binocular rivalry, two monocular images are simultaneously presented to a participant whose subjective perceptual experience alternates between each image. This "switching" between image percepts is of particular interest to researchers investigating the neural correlates of consciousness, as it demonstrates fluctuating conscious experience despite fixed physical stimulation. Evidence of a brain region's involvement in such percept switching has been taken to mean that the relevant activity should be considered a neural correlate of consciousness [2]. However, a recent study by Zou and colleagues [3] challenges this assumption.

In a series of elegant experiments, Zou and colleagues investigated whether binocular rivalry could be induced by invisible gratings. Results showed that participants were less likely to perceive a monocular low contrast (but visible) grating when it was paired with an invisible flickering grating with an orthogonal orientation, compared to when it was paired with a yellow disk or a uniform color flickering disk; participants were also less likely to correctly identify a monocular test probe's orientation when the other eye was given the invisible flickering grating than the other stimulus types. Interestingly, although visible stimuli activated visual, parietal, and frontal cortices, invisible stimuli only activated early-level visual areas, highlighting the possible role of lower-level visual regions in producing unconscious binocular rivalry. Combined, these results provide convincing evidence that invisible stimuli can induce binocular rivalry and support the idea that binocular rivalry may be caused by a low-level ocular selection mechanism.

The findings from Zou and colleagues cast doubt on the supposed link between binocular rivalry and conscious perception. These findings are reminiscent of previous arguments in the literature regarding similar effects [4–6]. As noted by Blake and colleagues, "What one ideally would want in the experimental search for [neural correlates of consciousness] is a procedure that not only leaves physical stimulation intact while perception fluctuates, but that also leaves all neural processing intact apart from that which is part of the [neural correlates of consciousness] for the particular perceptual states experienced by the observer. But the evidence indicates that binocular rivalry does not quite allow this idealized experimental approach" [4]. In other words, the changing percepts in binocular rivalry may simply be the result of fluctuating strengths of perceptual signals from early visual areas, rather than changes in conscious perception per se. Does this imply that binocular rivalry has nothing to do with consciousness?

Although binocular rivalry may not be uniquely linked to consciousness in terms of subjective experience, it is clear that the paradigm is still related to awareness in some important sense, as the brain regions responsible for percept switching directly influence the information represented by the visual system. To clarify how binocular rivalry is related to awareness, a conceptual distinction should be made between two types of awareness. Perceptual awareness constitutes the visual system's ability to process, detect, or distinguish among stimuli in order to perform (i.e., give responses to) a visual task. On the other hand, subjective awareness constitutes the visual system's ability to generate a subjective conscious experience. Although the two may seem conceptually highly related, operationally they are assessed by comparing different task conditions (Figure 1). To specifically assess subjective awareness but not perceptual awareness, one needs to make sure that perceptual performance is matched across conditions. One example of this type of contrast can be seen by comparing normal conscious vision against blindsight [7].

This distinction between perceptual and subjective awareness is congruent with Zou and colleagues' interpretation of the neural mechanisms associated with invisible binocular rivalry. They note that binocular rivalry could be caused by one of two processes: (1) higher-level regions (e.g., in frontal and parietal areas) that interpret perceptual signals and resolve interocular conflict may suppress one of the ocular representations, or (2) lower-level visual areas could automatically resolve interocular conflict regardless of higher-order perceptual interpretations by suppressing one eye's signal. According to the results of Zou and colleagues, it would appear that