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Look and feel

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The relation between vision and touch is an old chestnut, going back to the earliest days of psychology. The famous ‘Molyneux’s question’ asks whether a formerly blind person, to whom sight were suddenly restored by some unspecified miraculous medical intervention, would immediately be able to discriminate a sphere from a cube on visual presentation alone. The empiricist’s counter-argument is that it would be necessary to touch the objects first, in order to learn the relation between the objects’ retinal projection and their volumetric shape. The answer to this question would set a framework for studying interactions between sensory modalities: does touch lead vision or not?

Those who have revisited the question experimentally have generally been concerned with integration of visual and proprioceptive information about body position, rather than about external objects. Such studies have used tasks in which vision and somatic sensation give conflicting information, and have generally concluded that vision wins in such conflicts. To give just one example, vibrating the biceps tendon of the arm causes a compelling proprioceptive illusion in blindfolded subjects, in which the subject feels its elbow to be much more flexed, and their forearm much closer to the body than it really is. When subjects see their forearm during this procedure, there is no illusion of change in position. Several behavioural studies have suggested that our normal body position sense is a weighted combination of visual and proprioceptive inputs, and have discovered the rules of sensor fusion that the brain uses to combine them.

The recent discovery of bimodal cells in multiple brain areas, including the putamen, premotor and parietal cortices, has clarified how such multi-sensory information about body position is integrated in the brain. Interestingly, two classes of bimodal neurons were found in a recent study of monkey parietal cortex. When the monkey’s static arm was occluded from view, and a stuffed taxidermic arm moved across the workspace, some neurons showed visual receptive fields that shifted with the visually observed position of the fake arm. These neurons are clearly visually led, in that their response properties change when the visual inputs from the body change while the proprioceptive ones do not. Other neurons displayed the opposite behaviour: when the monkey moved its real arm unseen beneath the worksurface, but the fake arm remained statically in the same visible position above the surface, the visual receptive field shifted to coincide with the new felt position of the fake arm. These neurons are clearly somatically led, in that their response properties change when the proprioceptive inputs from the body change while the visual ones do not. From this evidence, it seems that the brain maintains multiple representations of body position, each generated by a different sensor fusion weighting.

What has been missing, up to now, has been the link between such multimodal neural representations and behavioural performance. One recent study suggests neuropsychological studies of brain damaged patients may provide that link. Newport, Hindle and Jackson tested a patient, ‘CT’, who had impaired somatosensation in her right limb following a thalamic lesion. In a matching task, the experimenters placed the index finger of one of the patient’s hands (the ‘target’ hand) unseen below the table-top, and asked the patient to reach out to place the index finger of her other hand (the ‘reaching’ hand) directly above the index finger of the target hand. The paper focuses on how the matching error (the distance between the two fingertips) varies as a result of the sensory information available during the task.

In one condition, CT was blindfolded, and thus no visual information about either target or reaching limb was available. She made large matching errors when her impaired hand was the target hand, but minimal errors when her normal hand was the target hand. The reduced somatosensory function made her impaired hand feel much closer to the body than it really was. Most interestingly, these large errors disappeared when CT was allowed to have vision of her unimpaired reaching hand. The conundrum is why did vision of the reaching hand help: the impaired target hand remained hidden from view beneath the worksurface, and vision of the reaching hand and of the top of the surface gave no clue to the target hand location underneath. The authors suggest that merely viewing the worksurface adjacent to the target limb can improve the proprioceptive representation of the target.

This finding requires a change in our thinking about sensor fusion. Previous studies using similar matching tasks proposed that the CNS integrates proprioceptive information with visual information about the position of the target limb. In the present case, however, degraded somatic information about limb position seems to be integrated and improved by some visual process that...
does not directly contribute information about the target limb position. What might this process be? Two possibilities exist in the literature. The first would be a process of initial visual calibration of position sense. Gordon et al. have shown that patients with proprioceptive loss show big improvements in aimed movement if they are allowed to glimpse briefly the starting position of the hand before movement. Proprioceptive information about limb position is known to drift over time. The initial visual signal presumably realigns the felt position of the limb with its seen position. However, the patient in the present study was blindfolded throughout the critical trials in which she made the hand were the scientists: three cognitive

I. Spatial errors.


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References

Form in time: the perceptual discovery of art

Carolyn Drake

The international colloquium, ‘Forme et temps: la perception au fil de l’oeuvre’, was held as part of the IRCAM Agora Festival at the Pompidou Center, Paris, France, on 6–8 June, 2001. The colloquium was organised by Stephen McAdams (Ircam-CNRS, France) and Roger Reynolds (University of California at San Diego, USA).

Imagine that you are listening to a piece of music you have never heard before, a longish piece, lasting more than ten minutes. To make things even harder, it is in a contemporary music style with which you are not very familiar. It is known that the composer wrote the piece with a clear structure in mind, with multiple musical ideas or themes following each other over time in a particular order, or occurring simultaneously as competing or complementary musical objects. Also, the conductor and musicians performing the piece are well aware of this structure because they have worked extensively with the composer.

The question that the brave organisers of this colloquium wished to address was exactly how much of this musical structure you are able to perceive, and what perceptual and cognitive processes must be involved to make this possible. In other words: to what extent are listeners able to identify musical form as it unfolds in time?

A meeting of artists and scientists

With this aim in mind, the psychologist Stephen McAdams and the composer Roger Reynolds brought together scientists and artists in Paris for three days of creative thinking around this theme, which has previously received very little serious consideration. The variety of approaches was impressive. On the one hand were the scientists: three cognitive