Report: 'What role for the distinction between the senses?' Workshop
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Themes

- *Does individuation of the senses matter for scientific investigation into multisensory processes?*

Does multisensory integration commit us to individuation? If multisensory integration requires tracking of reliability and this requires identification of sources of information, then we might have one reason for answering this question positively. But, would the system actually need to identify sources of information and can we equate sources of information as identified by the system with whole senses? What other evidence is there that individuation of the senses matters?

- *Can we make a mistake about the kind of experience we are having?*

Is it possible to be mistaken about what kind of experience one is having, and how might we test this? If we take the individuation of the senses to be derivative on the individuation of kinds of experience, then is it the case that our experiences are tagged as being of a certain kind such that we cannot be mistaken about the kind of experience we are having? What happens in crossmodal illusions?

- *Amodal signal processing*

Based on developmental psychology research, Andy Bremner described an existing framework for amodal signal processing. He however presented his own data which speaks to instances where, at least with regards to spatial representations, an amodal explanation seems inappropriate. Though not directly describing amodal qualities, Vincent Hayward put forward the notion of a single mechanic sense which might be theoretically considered as amodal or non-specific in nature. Noam Sagiv further suggested that some sensory information and even cognitive concepts (e.g. colour, gender) might be combined due to amodal qualities.

- *Reliability and redundancy of signals through different sensory channels*

Both Hong-Yu Wong and Vincent Hayward suggested that the reliability of the signal will determine the relative importance of multiple, concurrent streams of information related to a single event. Both Vincent Hayward and Andy Bremner discussed the idea that if multiple sensory channels produced signals pertaining to the same event, there may be a redundancy of the information or at least a weighting of this information with a preferential stream being relied upon depending on the reliability of the signal.

- *Mapping/co-representation of signals*

Andy Bremner provided evidence for crossmodal signals being associated and therefore similarly represented / mapped for improved efficiency of processing. However, his own research suggests that in some instances spatial co-representation seems unlikely or at the very least confusing to the system (in the case of the cross limb experiment). Noam's talk suggests that there may in fact be some overlap in the way sensory and more cognitive signals are similarly handled or perhaps even represented.

1. Fiona Macpherson

Individuating the senses: an overview

In her talk, Fiona Macpherson proposed that we make a type/token distinction when thinking about the individuation of the senses. A subject, 'Four-Eyes', with four eyes rather than two might be thought to have two tokens of the visual sense type, with two receptors per token, rather than one token of a visual sense-type with four receptors. The question, then, is how we individuate different token senses and different sensory types, where this is then understood as the question of whether a sense is a token of a particular type.

Macpherson argued that we shouldn't be conservative in judging how many perceptual sensory types humans have, arguing for a non-sparse view on which we are open to there being more than five sense modalities, potentially including proprioception, kinaesthesia, vestibular experience and pheromone reception, amongst others. Macpherson's proposal is that it is in answering the token question that we find a way of answering the type question, and one that takes us beyond the way that philosophers have typically tried to individuate the senses. Rather than focusing on a particular criterion (i.e., which objects or properties are represented; the phenomenal character; the proximal stimulus; the sense organs and brain regions involved) in order to individuate a sense as a token of a particular type, we should look for similarities and differences amongst different token senses across all four criteria in order to build up a space of sensory modalities. Principal component analysis could then allow us to reduce the number of dimensions of this sensory space, giving us a novel answer to the question of what matters for the individuation of the senses.

Questions:

- Should we assume that having two eyes give us just one visual sense? Perhaps the question is not simply whether Four-Eyes has one token of the visual sense type or two tokens of the visual sense type: we should consider the possibility that Four-Eyes has four tokens of vision.
- Using the type/token distinction, should we take the distinction between retronasal and orthonasal olfaction as a distinction between different tokens of one sense type, or different sense types, or should we retain the idea that there is just one token of the single sense type, smell?
- What reasons do we have for thinking that Four-Eyes has more than one token of vision: are the number of receptors that a creature has, relative to the number of receptors that we have, a good indicator of how many tokens of a sense type are instantiated in that creature?
- Does holding a sparse view of the number of senses (a view on which there are just five senses) commit us to thinking that science should not inform us about the senses? One approach might resist revision of our conception of the senses in the light of any scientific discovery. A more nuanced view might hold that its our folk conception of the senses that isn't liable to be altered in light of scientific investigation, because in talking about seeing, hearing, smelling, tasting and touching in everyday language we are not committed to their being a biologically recognizable natural kind picked out by each of those terms.
- Can we identify tokens prior to having answered the question about sense types? The proposal seems to require that we can make a judgment about how many token senses a creature has

without yet having a handle on what sensory types there are. But in order to judge whether a creature has a token sense it seems that we would have to know what sensory types there are, so that we could look to see how many times each type is instantiated in that creature.

- Might another criterion for individuating sensory types be provided by thinking about the senses as perceptual systems and asking what the function of each system is? For example, a creature with two sets of eyes, one set on one side of their head and the other set on the other side of their head, might count as having two different types of vision ('front'-vision and 'back'-vision, say) rather than two tokens of the one vision type.

2. Louise Richardson

Senses as faculties and modes of experience

In her presentation Louise Richardson adopted the view of the senses as being perceptual faculties. The question of the individuation of the senses, then, becomes a question about the individuation of perceptual faculties. Richardson explored two potential ways of approach the question of individuation: either by taking a sense to be a system that produces perceptual experience, thereby making the question of how to type kinds of experience derivative on the answer we give to the question of how to type sensory systems; or, by taking a sense to be a capacity for a particular kind of experience, for example, seeing. This would mean that we would first need to distinguish kinds of experience, and then use these distinctions to type capacities and therefore the senses. In thinking about how we might distinguish between different kinds of experience if we are to pursue this second approach, Richardson asked what the task is that we are we engaged in when we try to distinguish between the senses? While our tasks might be that of giving a larger psychological explanation, or conducting scientific research, we might also be interested in understanding the distinctions we make in ordinary language (although we should not assume that we don't all operate with several different distinctions: we shouldn't assume that there is a sharp and neat distinction between the way the folk think, on the one hand, and the way scientists think on the other). If so, the task seems to be that of finding out what underpins the distinctions we already make, and this might be a matter of finding out what, for example, seeings have in common such that we can think of them all as one kind of experience.

Questions:

- Does this way of thinking about the individuation of the senses assume that there is a particular philosophical question at stake that cannot be answered by looking at our everyday conception of the senses and looking at the data from empirical research and finding some kind of middle ground between the two?
- Can we be mistaken about the ways in which we are perceiving? If we adopt a kinds-of-experience-first approach, then we need to have a way of individuating kinds of experience. Could we have an experience, be able to report that we have perceived, but not be able to answer the question of how we have perceived?
- There are two possibilities here: one sort of confusion would be if subjects were mistaken about the type of experience they had, another would be if subjects were unable to say what type of

experience they had, but were only able to say that they perceived something. Is it possible for us to have an experience and know that we have perceived, but be unable to classify the kind of experience at all? If not, might it be possible for us to have an experience and know that we have perceived, but be mistaken about the kind of experience we have had?

- How we might test this? The problem with tackling a question like this empirically is that participants' responses will have to be forced choice: they will have to assign a (potentially new) experience to one of a set of pre-assigned categories. We need, then, to find a way of sharpening up the question to make it testable.

3. Andy Bremner

Do we develop the ability to process multisensory information amodally or as individual signals?

Overview

Research on multisensory perception in developmental psychology typically investigates whether experience drives differentiation or integration of the senses in infants. More specifically, developmental research, it is hoped, should help us understand whether infants process amodal sensory information or whether they are in fact able to perceive relations between stimuli in different senses. The talk briefly provided an historical perspective of the varied thoughts regarding individuation in both psychology and neuroscience. This was followed by a presentation of more recent findings which challenge the idea of amodal perception while highlighting the limitations of an account of the development of sensory individuation.

An historical perspective: integration or differentiation?

Up until the 1960s, developmental psychologists thought that multisensory processing was difficult for the newborn infant (James, 1890) and that, through experience, we learnt to deal with multisensory events by association (cf. Molyneux, Berkeley, Helmholtz). There was however no real empirical bases for these early theories. Moreover, empiricist and developmental integration perspectives did not align. There is still confusion over whether James believed the infant to be acting in an unintegrated vs. undifferentiated fashion. Piaget suggested integrative processing which enriches the cognitive understanding of the world.

Intersensory Redundancy Hypothesis and amodal processing

In contrast to James, Gibson (1969) puts forward a differentiation theory which suggests that the undifferentiated state is not confusing but rather informative, relying on the infant system being able to process so-called amodal properties of a sensory event.

"I mean the term [amodal] to suggest that there is information in stimulation which is not tied to specific sensations but is rather invariant over them"; "Intensive dimensions might be an example, but featural properties, such as sharpness, bluntness, and jerkiness.. ..are common to several modes."

Based on Gibson's theories, the intersensory redundancy hypothesis is the widely-cited account of multisensory development (Bahrick and Lickliter (2000, 2002, 2012) which suggests that multisensory information carrying equivalent/redundant information across modalities is coded in a common representational format. Examples of amodal factors include tempo, spatial location, pattern, intensity

and duration. Beyond these commonly coded/represented factors, multisensory arbitrary correspondences will emerge later and will carry distinct information in separate modalities (e.g., the colour of an instrument and the sound it makes). This line of thinking both allows for a reconciliation of differentiation and integration accounts and is supported by a large body of evidence (mainly from infants) including the fact that there are observable effects of early detection of intersensory redundancy (suggestive of processing of amodal properties) as well as that stimuli with intersensory redundancy factors have been shown to facilitate learning about arbitrary relations. For example: evidence that manipulating supposed amodal properties (intensity and synchrony), facilitated responses in young infants (Lewkowicz, 1980, 1996). Moreover, evidence suggests that reliance on crossmodal relations (monkey calls and facial gestures) declines with age; i.e. multisensory perceptual narrowing and differentiation (Lewkowicz & Ghazanfar, 2009).

Evidence against amodal processing: crossmodal mapping in space

Data from young infants shows that there is early difficulty with perceiving the multisensory spatial links between touch and vision. However, it is debatable whether this is suggestive of immature multisensory processing or difficulty in coordinating crossmodal responses. ERP data show a reliable postural modulation of the SEP from 10 months with a more positive SEP in the crossed posture from 58 ms at central sites. Work in adults has demonstrated that early visual experience is an important factor in our perceiving touch in external coordinates. Specifically, congenitally blind individuals have been shown to have a different and seemingly external spatial coordinate system. Similar studies in infants show that multimodal (visual and tactile) events result in a conflict of the spatial coordinate system with younger (3.5 month old) infants showing a quicker and more accurate response than 6 month old infants. This puts into question the amodal quality of space instead implicating that it is separated (at least initially) across the senses.

Broader questions:

- Does the infant and adult brain process amodal sensory information in a manner that in turn facilitates multimodal processing?
- What is the neural signature of amodal sensory processing? (Giandomenico Iannetti ERP data) – is it just an attentional priming effect?
- If the system does in fact develop beyond amodal sensory processing (toward individuation), does the capacity or relative importance of amodal processing diminish with development?
- If there are amodal properties – what would they be (disagreement in the literature)?
- What if any are the differences between amodal and multimodal properties?

4. Hong Yu Wong

The Bodily Senses

In his talk Hong Yu Wong presented an alternative way of thinking about the individuation of the senses, indicating the relevance of doing so for science. He started by unpacking the complexities in thinking about the bodily senses and arguing that the body schema, a system of sub-personal motor capacities,

must be multisensory and needs to be updated regularly in order to be used for the online control of action. Action in the environment requires accuracy, so we need to maximize the reliability of the information we have about the world and about our bodies. According to Ernst & Bülthoff's (2004) we can think of multisensory interactions as being of two kinds: sensory combination is the interaction between sensory signals that are not redundant (i.e., they are in different units, coordinate systems, or about distinct aspects of the same property); sensory integration is the interaction between redundant signals (i.e., in the same units, coordinates and the same aspect of the same property). The integration of redundant signals raises the question of which modality 'wins': if one has information through touch and vision about the size of an object, is one's perception of the size of the object determined by the visual or haptic estimate? Ernst & Bülthoff report on studies that show that the integration of information across sensory modalities uses a linear weighting rule where weights depend on the signal's reliability (2004, 165-166). In other words, the system tracks the reliability of different sources of information and treats information differently depending on the reliability of the source/information. This may not give us a set of criteria for individuating the senses, but it indicates that the system, in tracking reliability, individuates different sources of information.

Questions:

- How does the system track reliability? The process of tracking reliability might be thought of as taking as input other processes (i.e., the channel or source of information), or it might simply be a process that tracks stimuli. If the latter is the correct way to think about the reliability-tracking system, then the system would not be demarcating different channels as inputs to the process, and we therefore shouldn't talk of the individuation of sources of information.
- What about classification? Even if we accept that the reliability-tracking mechanism involves the identification of particular sources of information, we might think that there isn't any classification by the system of those sources as of a particular kind. One way, though, in which it might seem to do this is that reliability is measured relative to past performance of a particular source of information. So for example, vision could only be measured as unreliable (e.g., blurry) when compared to normal vision. So, the system needs at least to keep track of sources of information.
- If the channels through which we get information are not pre-fixed, then what the system treats as an information channel in terms of monitoring of reliability might be fluid and dynamic. If so, in what way does the reliability-tracking system help us in the individuation of the senses?
- What would be the outcome of partial changes to the reliability of a channel, for example, if half the visual field was degraded? Would the system disregard the whole visual information channel on that basis, or would the system end up with two channels? We need some independent handle on what counts as noise for the system in order to understand what would count as partial reliability.
- Should noise be understood only as sense-sized? For example, colour vision, specifically, might be unreliable. The reliability-tracking process might distinguish a large number of distinct sources of information based on a fine-grained approach to the tracking of reliability. If we take the number of sources of information treated by the system as distinct as indicative of how many

senses there are, the approach has the potential to offer a highly revisionary answer to the question of what and how many senses there are.

- Might conscious experience play a role in adjudicating which of the sources of information would count as a sense? We have some handle on what counts as a sensory modality based on how things seem, so we might take conscious experience to be able to distinguish genuinely sensory sources of information from non-sensory sources of information.

5. Noam Sagiv

Can social synaesthetic experiences provide us with a clearer idea of how the brain deals with combinations of sensory and non-sensory information?

Overview

The talk started with the incomplete and flexible definition of synaesthesia and whether this account of multimodal sensory processing could be extended to scenarios in which more cognitive conceptual instances could be associated with a second cognitive ***or*** sensory experience. Can the definition be extended to the somewhat extreme one offered up by Hubbard (2007): "an experience in which stimulation in one sensory or cognitive stream leads to associated experiences in a second, unstimulated stream".

Expanding the definition of synaesthesia

An historical perspective was provided showing how the definition has already shifted beyond describing a purely sensory phenomenon to instances such as coloured grapheme synaesthesia calling into question whether instances in which the inducer, or the concurrent is not necessarily sensory can be included in the definition. The extension of the definition to include grapheme personification brings to the fore the idea of amodal cues (e.g. gender – see Andy Bremner's talk) and the mapping between cognitive domains (i.e. outside of sense-based synaesthesia). Can personification be a sensory experience? Is there an intersection between synaesthesia and crossmodal interactions? Rather than including these non-sensory experiences into the synaesthesia definition, they have been described as synaesthesia-like or related phenomenon. It was therefore suggested that perhaps one could describe spectrum of synesthetic phenomena with a common aetiology.

Social side of synaesthesia

Grapheme/object personification may be attributable to a form of hypermentalising whereby individuals infer the mental state of letters or inanimate objects. Empirical investigations have included a simple Stroop-like task. Clustering of the effect though has yet to be studied. The neural correlates (from an n=1 study using a 1-back, personification-irrelevant task) shows that gender is associated in only some letters with correlated precuneus activity. Inanimate personification has been studied less but on-going research suggests that it is object specific (humanlike proportions). Acquired data indicates that empathy is not sufficient to provide the effect but rather that it relies on social networks and possibly self-referential processing (synesthetic events may reflect aspects of the individual's own experience/mental states). There seem to be both benign and delusional cases of personification and is a normal daily capacity in all individuals which seems to be extended to unusual categories in social synaesthetes.

Classifying synesthetic-like experience

It was questioned whether consistency or automaticity were essential for determining whether or not the observed effect could be classified as synesthetic. It was suggested that an individual's variable behaviour, if sufficiently intense, could theoretically be classed as synesthetic. Alternative methods for testing the intensity of the effect were discussed (e.g. genetic screening, galvanic skin response – GSR – measures of arousal). Moreover it was queried whether a naturally occurring variation across the population (with individuals at the extremes demonstrating synesthetic tendencies e.g. mentalising is a common trait across neurotypical individuals but hypermentalising resulting in object personification is an extreme) could describe a spectrum of synesthetic-like traits or whether there was in fact something different and more specific that results in an individual possessing synaesthesia. The potential for genetic screening was discussed with the potential to pinpoint a synesthetic genotype. The nature of triggering stimuli was highlighted, with colour in particular being described as possessing a certain quality (amodal quality) which meant that it was labile and not secure in its allocation. Moreover, the differing clustering of inter- and intramodal stimuli was highlighted.

Other questions explored included:

- Can we accommodate individual differences into our preferred framework for individuating the senses?
- Does the synaesthetic experience merely represent an additive effect or a qualitatively different type of experience / mode of perception?
- Why does sensory development take a different course in some individuals and not others?
- How does non-sensory information mesh with sensory information in synaesthesia and what does it tell us about our chances of making sense of the senses without talking about language, social cognition, and other higher functions?

6. Vincent Hayward

Can sensory signal processing be reduced to mechanics? What do you DO when you FEEL?

Overview

The talk put forward that the mechanical functioning senses relied on mechanical phenomena (some physical and some chemical). Though the specific channels used may differ as well as the context in which they operate, the mechanics underlying survival are similar – that is, there is specificity in function but unspecific underlying mechanics. The examples given generally revolved around visual and phenhaptic functions. The central reasoning behind this would be that the infinite dimensions of variance within even a single sensory modality requires simplification (e.g. local deformation assumption; hysteresis=memory). In the example of the most simple of haptic probes, a paramecium, we see that exploring infinite dimensions is simplified by goal directed behaviour and the use of memory and mechanical deformation changes.

Intuition about mechanics underlying perception are incorrect

In touch, we never feel pressure despite pressure related receptors. A more visceral example is that of surgical reconnection of an amputated hand after which mechanics are immediately available while sensory fibres are still in recovery and the hand is described as numb. The feeling and tactile function is restored over time and this progress is tracked using a sensory discrimination test. Despite the lack of tactile function in the hand, individuals are able to identify sandpaper qualities attributable to measurable mechanical activity at the tendon (removed from contact point) thus allowing for discrimination. Are muscles doing the sensing? In fact, muscle spindles are sensitive to a wide range of senses. Although the presence of these mechanoreceptors in the tendons are only supplementary to tactile channels in the skin, this puts into question where we locate touch channels and undermines the idea of specificity of the senses. The parchment skin illusion is a further example of how information through various channels changes the perception of the state of self (in this case, skin roughness through auditory information – whereby physics influence which channel's information is prioritized). Similarly, it is the muscles not the joints that provide information as to the position in space suggesting that consciousness of bodily position is related to outer skin. These examples point to the fact that there is not a clear relation between mechanics and the role.

The true notion of information: quality, reliability and sensitivity thresholds

Touch and vision both provide useful information to facilitate the ability to stand, to assess and to move objects. Specifically, the size inertia illusion (a smaller object is perceived as heavier) suggests that information through separate channels is used differentially (is weighted differently according to function) in making perceptual weight judgments. Pressing force experiments moreover show that there is a non-linear relation between the nature of the stimulation and the observed/perceived response. Rather, despite force being applied, it is only if there is a change in force that a response is generated. The physical state is determined by internal receptors but it is the state of the external rather than internal activity that determines the nature of the response. The relation of your body to the world depends on micromechanics. The role of the brain is then to disambiguate the various signals. The mechanical system is thought to be tuned with the sensitivity of the system relying on detection thresholds (for example, the system seems to more sensitive for auditory stimuli than tactile stimuli – see acoustic emission plot). For example, an ant crawling on the skin is felt but not heard (small objects are felt better than they are heard) suggesting that the world can be separated by size (and size of the signal produced). Audition and touch are both mechanical senses in the same world but they act through distinct channels and show a size variation effect. These concepts can be extended to optics with visual system showing less sensitivity to small degrees of motion. From a physical point of view, it was suggested that to detect the mechanical state of the body there is really only one sense. Individuation is based on the nature of the proximal stimulus. Organisms are programmed to use their mechanical skills to detect changes in the mechanical state of the world around them.

Post-talk discussion and questions

- Are smell and flavour mechanical? Yes but more directly speaking, the mechanical nature of these channels is based on chemistry rather than physics with the underlying mechanism being

that of the movement of molecules and the detection of gradient changes (combined result in changes in energy).

- Validity of the stimulus criterion: Undermined by mechanics hypothesis but is relative to the functioning of each animal
- Subjective experience: Hand transplant example suggests that as the sensation is mediated by different class of channels but curious as to whether the subjective experience is the same.
- Redundancy of the information: Although the system receives different forms of information pertaining to the same stimulus, is this information redundant or different and still useful?

Roundtable discussion

Is it possible for us to have the same subjective experience through stimulation of different receptors? Some potential examples might include:

- auditory illusions in which subjects hear tones when the relevant hair cells in the inner ear have not been stimulated; and
- subjects' reports of having taste experiences when they have trigeminal nerve stimulation resulting from Szechuan pepper being painted on the lips.

The question of whether we can be confused or mistaken about the type of experience might be answered by claiming that sensory experiences have a modal signature or tag, which marks the experience as an experience of a particular type. The suggestion is that tagging would take place early on in processing rather than being a personal-level classification. The experience would bear a trace of how it was tagged, such that we couldn't make mistakes about what kind of experience we are having. If our experiences have been tagged, then we will know what kind of experience we are having.

In order to test whether it's possible for subjects to make mistakes about the kind of experience they are having we could present two different sensory stimuli at threshold to see if subjects become confused about, e.g., whether they felt or saw something. Using bimodal stimuli we could look for three outcomes: cases in which participants don't know what kind of experience they are having at all; cases in which participants are confused about the kind of experience they are having; and, cases in which participants are not confused at all.

Would the consequences of integration of sensory information from *multiple* modalities be two modally distinguished tagged experiences, or a new experience, which would either be untagged or could perhaps have a new kind of tag? In the McGurk effect people usually report that they have *heard* /da/, i.e., they think they have had an auditory experience of /da/. Perhaps, though, when the visual influences the auditory in this way we shouldn't say that there has been a change in something modality-specific, in this case auditory, but rather that subjects have had a new audio-visual experience which they have mistakenly classified as purely auditory. The reason we might want to resist the idea that it is purely an auditory experience is that we cannot take the visual experience away (if you close your eyes the effect goes away). How can we distinguish between these possibilities, and what role would tagging play in classifying the type of experience they have and explaining subjects' propensity to describe their experience as auditory? Should we treat the resulting experience as a new kind of experience rather

than just the summation of audition and vision? And can we say which tag has 'won' – the auditory tag or the visual tag?

How might tagging work? If we take tagging to be sensitive to particular patterns of input, then how can we reconcile this with the fact that we can produce visual experiences (experiences that are tagged as visual) with direct stimulation of the visual cortex?
One option is that it is the structural properties of an experience, determined by physiology, that generate the tag and result in differences in phenomenology between different kinds of experience, allowing us to make judgements about what kind of sensory experience we are having. If this is right, then what should we say about tactile-visual sensory substitution (TVSS)? Does the new experience have the modal signature of vision if the structural features of vision are produced within it?

Mriganka Sur and colleagues redirected signals from the retinas of ferrets to the auditory cortex (von Melchner et al. 2000). The result was that flashes of light were treated like visual stimuli. Does this show that the tagging process is determined by task instead?

A further option would take explanations of the sense of agency as models for how tagging of different kinds of sensory experience might occur. When an action is accompanied by a sense of agency we can understand this as involving the action being tagged as one's own. It's important to bear in mind, though, that actions can only be classified as one's own or not one's own. It is therefore possible that there is no positive tagging process and a sense of agency is generated whenever an action is tagged as not one's own.

Is tagging the result of conventional learning? If we incorporate the idea of experiences being tagged with the view of early experience as multimodal attributed to William James by Andy Bremner in his talk, then we should say that tagging is learnt.

In what ways does multisensory integration commit us to individuation? Hong Yu Wong's presentation gives us one example of why scientific explanation of multisensory processes might require us to recognize that there are distinct kinds of senses and perhaps to individuate those senses, but what other evidence is there that requires us to individuate the senses? One piece of evidence is that of enhancement effects that occur when bimodal stimuli are presented but not when unimodal stimuli are presented. For example, auditory-visual stimulation grabs attention while auditory-auditory stimulation does not.