UK Synaesthesia Association Annual Conference
14-15 April 2012
Merton College, University of Oxford

Saturday 14 April

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## Sunday 15 April

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| 10.00   | *Ideaesthesia: When semantic inducers associate sensory concurrents*  
Uta Maria Jürgens, Department of Neurophysiology, Max-Planck-Institute for Brain Research, and Institut für Psychologie, Christian-Albrechts-Universität, Kiel, Germany |
| 10.30   | *Explorations in time-space synaesthesia: From vantage point preference to the Sisters*  
Dr Mark Stewart, Dept. of Psychology, Willamette University, Oregon, USA |
| 11.00   | *How synaesthesia affects different memory systems and processes*  
Dr Nicolas Rothen, Sackler Centre for Consciousness Science, Department of Psychology, University of Sussex, Brighton, UK |

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| 12.00   | *fMRI analysis of the "right" and "wrong" colours in grapheme-colour synaesthesia*  
Ms Cassandra Gould, Sackler Centre for Consciousness Science, and Dept. of Informatics, University of Sussex, Brighton, UK |
| 12.30   | *Look ear! Learning to use a visual-to-auditory sensory substitution device*  
Dr David J. Brown, Queen Mary University of London, London, UK |
| 13.00   | *Mirrored Taste and Mirrored Smell*  
Alireza Ilbeigi and Sean Williams, Department of Psychology, School of Social Sciences, Brunel University, London, UK |
| 13.30   | Lunch at Merton College Old Dining Hall |
| 14.30   | Posters at the Atrium |

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| 15.15     | *The Ambiguous Synaesthesia of Olivier Messiaen*  
Ms Solange Glasser, the University of Paris IV Sorbonne, and the Municipal Conservatorium of Music, Paris. |
| 15.45     | *Girl in motion (film presentation)*  
Written and directed by Phil Bowman; produced by Matt Lawson, who will present the film |
| 16.15     | Closing remarks and Farewell |
**Poster Presentations**

**Do synaesthetic graphemes and colours bind unconsciously?**  
Hazel Anderson, Ryan Scott, Zoltan Dienes, Anil Seth, & Jamie Ward

**I saw that coming: Expected touch and internal imagery in mirror-touch synaesthesia**  
Marc Bloomfield & Mary Jane Spiller

**It feels like it’s me: interpersonal multisensory stimulation enhances somatosensory mapping of shared tactile stimuli**  
Flavia Cardini, Ana Tajadura-Jimenez, Andrea Serino, & Manos Tsakiris

**Effects of non-symbolic numerical information suggest the existence of magnitude–space synesthesia**  
Limor Gertner, Isabel Arend & Avishai Henik

**Musical shapes on breathing walls: Psychedelic synaesthesia**  
David Luke & Devin Blair Terhune

**Visual search in synaesthesia: Are there synaesthesia-specific redundancy gains?**  
Beat Meier, Nicolas Rothen, Alain Chavaillaz & Joseph Krummenacher

**Visual-music brain: Pilot study on the relationship between the primary visual cortex, mental imagery and synesthetic experiences**  
Giuseppe Passalacqua, Barbara Colombo, Guglielmo Pugliesi, & Chiara Di Nuzzo

**Focusing the mind’s eye: Grapheme-colour synaesthesia from imagining explicit and implicit letter properties**  
Ceydan Serinsu & Mary Jane Spiller

**Working memory and executive functions in synaesthesia**  
Tünde Sipka & Dezso Nemeth

**Is self-projection the key to understanding the attribution of agency to graphemes in sequence-personality synaesthesia: A neuroimaging study**  
Monika Sobczak, Adrian Williams, & Noam Sagiv

**Posthypnotic manipulation of the visuospatial phenomenology of colour photisms modulates selective attention in synaesthesia**  
Devin Blair Terhune & Roi Cohen Kadosh

**Time-space synaesthesia and cognitive advantages**  
Andrea Wantz & Beat Meier
Oral Presentation Abstracts

Saturday 14 April

Are we all synaesthetes? Weakening the case for ‘weak synaesthesia’

Charles Spence¹ & Ophelia Deroy²

¹Crossmodal Laboratory, University of Oxford, Oxford, UK
²Centre for the Study of the Senses, University of London, London, UK

Since Martino and Marks (2001) first put forward their influential claim that cases of intuitive matchings between stimuli across sensory modalities should be considered a weak form of synaesthesia, many other researchers have agreed at the very least implicitly, with this position (e.g., Bien et al., 2012; Eagleman, 2009; Esterman et al., 2006; Ludwig et al., 2011; Mulvenna & Walsh, 2006; Sagiv & Ward, 2006). The growing number of studies dedicated to these intriguing phenomena (see Deroy & Spence, submitted), as well as the multiplication of labels they come under, makes it timely to revisit the principle on which they have been said to be continuous with canonical cases of synaesthesia, such as coloured-hearing.

We first analyse the appeal of this ‘assimilationist’ view, demonstrating that the increasingly frequent claim that these cases are synaesthetic comes from overt similarities in terms of consistency and behavioural effects, as well as from the relaxing of two criteria once considered central to the definition of synaesthesia (the necessity of a conscious concurrent and the rare incidence of the phenomenon in the general population). The relaxing of these criteria, we argue, is made visible by the inclusion of non-conscious bidirectional correlates of crossmodal mappings in the study of synaesthetes, and of more frequent varieties of crossmodal experiences (such as mirror-touch or smell-induced taste) being labelled as synaesthesia. The result is the continuum thesis, according to which synaesthesia ranges from frequent cases without any necessary conscious concurrent to rare cases with a conscious (and often specific) concurrent.

This view is, however, inappropriate and, as we argue, potentially misleading. First, we stress that the continuum model is not explanatory, nor fully validated by the existing variations in consciousness and frequency, which might well be orthogonal dimensions. Second, we show that key differences between these apparently similar phenomena are being missed out by the assimilation. The absolute character, unidirectionality, and intransitivity of conscious, or canonical synaesthesia differ in important respects from the non-conscious kind (what are often referred to as crossmodal correspondences), and certainly differ enough to justify keeping these later cases as a distinct kind of phenomenon.

Pushing this ‘separatist’ view even further, we argue that these phenomena should be studied in their own right and not assimilated, either in terms of name or in terms of explanation, to synaesthesia. Crossmodal correspondences present different patterns of acquisition and neurological underpinnings from canonical synaesthesia, and are also found in both animals
(Farago et al., 2010; Ludwig et al., 2011) and, we argue, in infants/neonates (contrary to the interpretation of Maurer, 1993, which sees them as having a form of generalised synaesthesia). This model better explains why correspondences can play a role in multisensory interactions (Parise & Spence, 2009) and act there as a little consider form of ‘coupling prior’ (Ernst, 2007).

In conclusion, we stress that correspondences constitute an independent field of inquiry for multisensory interactions, whose investigation should be detached from that of synaesthesia and pursued more systematically. Implications for the varieties and definitions of synaesthesia are drawn.
Synaesthesia quotient: Individual index of expression of general neurocognitive aspects in developmental synaesthesia and its methodological implications

Anton V. Sidoroff-Dorso

Cross-Departmental Chair of Psychology, Moscow Pedagogical State University, Russia

Not all synaesthetic brains are equally synaesthetic. Not regarding the qualities of experiential content but the fact that extant varieties of synaesthesia are quantitatively different in intensity, prominence, consistency, proneness to diminution and age-dependent attrition, and other variables. Therefore, I proposed that these content-neutral aspects should be methodologically encapsulated in a notion of synaesthesia quotient (SynQ). Synaesthesia quotient is an index of the individual degree of overall expression of synaesthesia identifiable experientially, behaviourally and neurophysiologically. Currently, SynQ is an operational construct and has been substantiated by the data presented in scientific literature. Specifically, a person with higher SynQ will be a poly-aspectual rather than singular-type synaesthete; they experience an all-modality rather than selective, category-embedded synaesthesia; their inducers are likely to be more protopathic than epicritic; a high SynQ case is a projector type rather than associator, etc. My talk will focus on how empirical methods can be devised for testing and measuring synaesthesia quotient based on intrinsic correlations of content-neutral aspects (Sidoroff-Dorso, 2012) and some results of objective methods. Although a full-fledged paradigm is yet to be constructed, I suggest that measurable cross-type invariants are analytically available and experimental techniques are feasible to give grounds for a rigorous SynQ test inventory. SynQ will prove instrumental in establishing correlative regularities between congenital synaesthesia and, for instance, mental imagery, cognitive interference and memory facilitation.
Synaesthetic reclassified: From canonical to borderline cases of ‘sensory unions’

Ophelia Deroy¹ & Charles Spence²

¹Centre for the Study of the Senses, University of London, London, UK
²Crossmodal Laboratory, University of Oxford, Oxford, UK

Individuals for whom an idiosyncratic concurrent in one sensory modality is automatically and consistently triggered by an inducer presented in another modality are widely considered as constituting canonical examples of synaesthesia. Here, we argue that the three criteria of consistency, idiosyncrasy, and automaticity (or CIA for short) fail to provide a robust means by which to identify putatively novel cases of crossmodal synaesthesia. As a result, regular crossmodal relations experienced by the majority of individuals are nowadays increasingly being classified, inappropriately in our view, as synaesthetic.

We show this through three distinct sets of cases, selected because they range across the modalities, vary widely in terms of their incidence in the general population (from universal to rare) and in terms of their assimilation to synaesthesia.

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<th>Concurrent</th>
<th>Prevalence</th>
<th>Assimilated to synaesthesia</th>
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<td>Audition</td>
<td>Visual experiences</td>
<td>Frequent</td>
<td>Seldom</td>
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<tr>
<td>Olfaction</td>
<td>Taste-like or oral-somatosensory experiences</td>
<td>Universal</td>
<td>Recently (Stevenson, 1997)</td>
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<tr>
<td>Vision of someone being touched</td>
<td>Tactile experiences</td>
<td>Rare</td>
<td>Yes (‘mirror touch’)</td>
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These three cases all satisfy, to one degree or another, the CIA criteria for synaesthesia, and have indeed all been labelled as such by researchers. Rather than including these cases within the broad canon of synaesthesia, we argue that this demonstrates the insufficiency of the CIA definition of synaesthesia, adopted nowadays by the majority of researchers.

We show why adding criteria concerning the vividness of the concurrent and the lack of control over its content can help to rank these three cases along a continuum from the more to the less synaesthetic. That said, it still fails to provide a clear distinction between kinds of phenomena.

We argue that other characteristic features of these crossmodally-induced experiences therefore need to be considered, specifically, their representational character, their susceptibility to adaptation, and their malleability in the face of novel experience.

Two conclusions are drawn:
- regarding three sets of cases considered here, which are reclassified as non-synaesthetic;
- regarding the classification of problematic, or emerging, borderline cases.
Perceptual processing in synaesthesia

Michael Banissy¹,³, Neil Muggleton²,³, Agnieszka Janik¹, Vincent Walsh³, & Jamie Ward⁴

¹Department of Psychology, Goldsmiths University of London, London, UK
²Institute of Cognitive Neuroscience, National Centre University, Taiwan
³Institute of Cognitive Neuroscience, UCL, London, UK
⁴Sackler Centre for Consciousness Studies, University of Sussex, Brighton, UK

While the authenticity of synaesthesia is well established, fewer studies have addressed whether synaesthesia is linked to more widespread differences in perception that extend beyond the synaesthetic experience itself. This talk will discuss findings from our own neuroimaging and psychophysical investigations examining perceptual processing in synaesthesia. This will include findings from a voxel-based morphometry study in grapheme and tone-colour synaesthesia showing that these variants of synaesthesia are associated with increased gray matter volume in posterior fusiform gyrus but a reduction in MT / V5, and psychophysical studies demonstrating differences between grapheme-colour synaesthetes and non-synaesthetes in their processing of colour and motion. It will be argued that synaesthesia for colour is linked to wider perceptual manifestations that extend beyond the synaesthetic experience and potential mechanisms that may contribute to this will be discussed.
Feeling touch from seeing touch in developmental synaesthesia: A hyperactive tactile mirror system?

Jamie Ward¹, Henning Holle¹, & Michael Banissy²

¹University of Sussex, Brighton, UK
²Goldsmith’s College, London, UK

Objectives: To discover the functional and structural neural correlates of ‘mirror touch synaesthesia’ in which people report tactile sensations as a result of seeing touch on others.

Methods: We conducted an fMRI study in which participants (synaesthetes, controls) watch movies of stimuli (face, dummy, object) being touched or approached. In addition we examined the structural differences in the brain using VBM and DTI.

Results: Both synaesthetes and controls activated the somatosensory system (primary and secondary somatosensory cortices, SI and SII) when viewing touch, and the same regions were activated (in a separate analysis) when feeling touch – i.e. there is a mirror system for touch. However, SII (but not SI) discriminated between the two groups on a number of measures: it was hyper-active for watching touch to a face in synaesthetes; it correlated with subjective intensity measures (taken outside the scanner); and it was associated with increased grey matter density. In addition, the synaesthetes showed hypo-activity when watching touch to a dummy in an adjacent region of SII.

Conclusions: The secondary somatosensory cortex has a key role in this form of synaesthesia, and this fits with a number of models of multi-sensory processing.
The sound of size: combined TMS-EEG results on pitch-size associations support the spectrum theory of synaesthesia

Nina Bien\textsuperscript{1,2}, Sanne ten Oever\textsuperscript{2}, Rainer Goebel\textsuperscript{2} & Alexander T. Sack\textsuperscript{2}

\textsuperscript{1}EMACS Unit, University of Luxembourg, Luxemburg
\textsuperscript{2}Department of Cognitive Neuroscience, Maastricht University, Maastricht, the Netherlands

Studies investigating synaesthesia usually focus on extreme examples, contrasting the behaviour, cortical activation patterns or brain connectivity of synaesthetes with those of non-synaesthetic individuals. However, there is growing evidence that synaesthesia is in fact a common, widespread and often adaptive condition, representing a continuum ranging from normal cross-modal processes to extreme forms of synaesthesia. We propose that widespread, subtle forms of synaesthesia provide cross-modal mapping patterns which underlie and influence multisensory perception.

Our aim was to investigate if such a mechanism plays a role in the case of audiovisual pitch-size stimulus combinations. Using a combination of psychophysics and ERPs, we could show that despite violations of spatial correspondence, the brain specifically integrates certain stimulus combinations which are semantically congruent, thereby impairing performance on an auditory spatial localisation task (ventriloquist effect). Subsequently, we perturbed this process by functionally disrupting a brain area known for its role in multisensory processes, the right intraparietal sulcus, and observed how the ventriloquist effect was abolished, thereby actually increasing behavioural performance. Correlating behavioural, TMS and ERP results, we could retrace the origin of the synaesthestic pitch-size mappings to a right intraparietal involvement around 250 ms.

Our results provide more evidence for shifting the current viewpoint more towards synaesthesia being at the extremity of a spectrum of normal, adaptive perceptual processes, entailing close interplay between the different sensory systems. Our results support this spectrum view of synaesthesia by demonstrating that its neural basis crucially depends on normal multisensory processes.
Beware the Boojum: Synaesthesia and the SNARC effect

Clare Jonas¹, Mary Jane Spiller², Ashok Jansari², & Jamie Ward³

¹School of Psychology, University of St Andrews, St Andrews, UK
²School of Psychology, University of East London, London, UK
³School of Psychology, University of Sussex, Brighton, UK

One of the most common forms of synaesthesia is number-form, in which numbers take on explicit positions in space. However, non-synaesthetes are also known to map number onto space, though in implicit and predictable ways. For example, those who are literate in a language that is written in a left-to-right direction are likely to assign small numbers to the left side of space and large numbers to the right side of space (e.g. Dehaene, Bossini, & Giraux, 1993). In non-synaesthetes, this mapping is flexible (e.g. numbers map onto a circular form if the participant is primed to do so by the appearance of a clock-face), which has been interpreted as a response to task demands (e.g. Bächtold, Baumüller, & Brugger, 1998) or as evidence of a linguistically-mediated, rather than a direct, link between number and space (e.g. Proctor & Cho, 2006). The current study investigated whether synaesthetes’ number forms show the same flexibility during an odd-or-even judgement task that tapped linguistic associations between number and space (following Gevers et al., 2010). Synaesthetes and non-synaesthetes alike mapped small numbers to the verbal label ‘left’ and large numbers to the verbal label ‘right’. This surprising result may indicate that synaesthetes’ number forms are also the result of a linguistic link between number and space, instead of a direct link between the two, or that performance on tasks such as these is not mediated by the number form.
Exploring synaesthetes' mental imagery abilities across multiple sensory modalities

Mary Jane Spiller\(^1\), Clare Jonas\(^2\), Julia Simner\(^3\), & Ashok Jansari\(^1\)

\(^1\)School of Psychology, University of East London, London, UK
\(^2\)School of Psychology, University of St Andrews, St Andrews, UK
\(^3\)Department of Psychology, University of Edinburgh, Edinburgh, UK

Previous research on the mental imagery abilities of synaesthetes has found that synaesthetes report more vivid visual imagery (Barnett and Newell, 2008) and do better than non-synaesthetes on some measures of visual and spatial imagery (Price, 2009; 2010; Simner et al, 2008; Spiller & Jansari, 2008). However these studies are limited to often quite small samples, of a limited range of synaesthetes and imagery modalities. We extend the investigation of mental imagery to a wider variety of synaesthesia types and a wider variety of sensory modalities using a questionnaire study and several tests of visual and auditory mental imagery ability. Our results indicate that, as a group, synaesthetes report making greater use of mental imagery than non-synaesthetes, in everyday activities. Furthermore, they self-report greater vividness of visual, auditory, tactile, and taste imagery than do non-synaesthetes. However, as a group the synaesthetes are not seen to do significantly better at the mental imagery tasks, in either the visual or auditory modalities. These results have important implications for our understanding of synaesthesia, in relation to potential fundamental differences in perceptual processing of synaesthetes and non-synaesthetes.
Seeing touch and feeling touch: Interpersonal multisensory stimulation and interoceptive awareness modulate self-other boundaries

Ana Tajadura-Jiménez & Manos Tsakiris

Laboratory of Action and Body, Department of Psychology, Royal Holloway, University of London, Egham, Surrey, UK

‘Mirror-touch’ synaesthetes often feel a tactile sensation on their body when observing touch to another person. This suggests a self-other merging by which the other person’s body is mapped onto one’s body. Multisensory integration can be used to elicit a similar self-other merging in the general population. In the “enfacement illusion”, seeing someone else’s face being touched at the same time as one’s own face results on the other face being assimilated in the mental representation of the self-face. We focused on this illusion to investigate how interoceptive and exteroceptive representations of one’s body might result in changes in the self-other boundaries. Participants were stroked on the left side of their face while they were seeing the face of an unfamiliar other person being stroked. Synchronous, but not asynchronous visuotactile stimulation, delivered on specularly congruent, but not incongruent, face locations, resulted on the participants assimilating features of the other’s face in the mental representation of their own face as evidenced by changes in self-recognition and in the participants’ autonomic responses to objects approaching the other’s face. Importantly, people with low interoceptive sensitivity experienced stronger enfacement illusion indicating that interoceptive sensitivity predicts the malleability of body representations. These results suggest that self-other distinction and recognition of the physical self might be based upon specific processes of self-body perception both from the outside (i.e. multisensory perception) and from within (i.e. interoception).
Sunday 15 April

Ideaesthesia: When semantic inducers associate sensory concurrents

Danko Nikolić¹,² & Uta Maria Jürgens¹,³

¹Department of Neurophysiology, Max-Planck-Institute for Brain Research, Frankfurt, Germany
²Frankfurt Institute for Advanced Studies, Frankfurt, Germany
³Institut für Psychologie, Christian-Albrechts-Universität, Kiel, Germany

One of the main problems in understanding synaesthesia is to determine whether it is a sensory or semantic phenomenon—a problem known also as distinction between ‘low-’ vs. ‘high-level’ synaesthesia. Initially, a low-level explanation based on ‘crossed senses’ dominated, and the evidence seems to have supported this view. In fact, in most forms of synaesthesia, the concurrents seem to have true perceptual quality. Meanwhile, however, evidence began accumulating that inducers have a semantic rather than perceptual nature, relating synaesthesia to high-level cognitive phenomena. These two sets of results, perceptual concurrents and conceptual inducers, are joined in the notion of ideaesthesia: "sensing ideas". We review several lines of evidence supporting this perspective, concluding that synaesthesia can be well explained by high-level semantic mechanisms that guide the choices and elicitation of low-level sensory concurrents.
Explorations in time-space synaesthesia: From vantage point preference to the Sisters M

Mark Stewart¹, Michelle Jarick², Daniel Smilek³, & Michael Dixon³

¹Department of Psychology, Willamette University, Oregon, USA
²Department of Psychology, University of British Columbia, Canada
³Department of Psychology, University of Waterloo, Waterloo, Canada

In time-space synaesthesia, units of time are perceived as organized in a rigid spatial form. While the basic format may be invariant for most synaesthetes, the viewing perspective is sometimes more flexible. I will present recent data from our work with the time-space synaesthete L, who adopts different viewpoints depending on whether she hears or sees the month. Briefly, by using a spatial-cueing task with central month names as cues, we demonstrate that L detects targets on her left faster following the written month January, yet faster on the right following the spoken month January. Moreover, L reports a preference for her auditory perspective, even though the month names are perceived upside down. We verified this by conducting a spatial-cueing test that included visual, auditory, and audiovisual month cues. Further, the audiovisual cues were either congruent (visual perspective consistent with auditory perspective), or incongruent (visual perspective inconsistent with auditory perspective). We observed that not only can L change perspectives within her time-space, but she has a clear preference for the auditory one. The second part of my talk will center on discussion of investigations currently underway in our laboratory involving the Sisters M. Each of these siblings, ranging in age and synaesthetic abilities, reports distinct time-space representations. Intriguing empirical questions are emerging at the interface of their idiosyncratic spatial representations and shared life experiences. I will provide an overview of the kinds of patterns we’re seeing with regard to how each sister experiences time and represents it three-dimensionally.
How synaesthesia affects different memory systems and processes

Nicolas Rothen\textsuperscript{1}, Anil Seth\textsuperscript{2}, & Jamie Ward\textsuperscript{1}

\textsuperscript{1}Sackler Centre for Consciousness Science, Department of Psychology, University of Sussex, Brighton, UK
\textsuperscript{2}Sackler Centre for Consciousness Science, Department of Informatics, University of Sussex, Brighton, UK

Although recent group studies have provided evidence for enhanced memory performance in synaesthesia, not much is known about the specific affected memory systems and processes or the underlying mechanisms by which synaesthesia influences performance. In order to shed more light on this issue, we tested grapheme-colour synaesthetes and demographically matched controls with three different memory paradigms. In the first, we used a continuous identification task with recognition (CID-R) to compare explicit and implicit memory processes in synaesthetes and non-synaesthetes. In the second, a digit-span task was used to evaluate the impact of presentation mode (visual v. spoken digits) on short-term memory performance between these two groups. Finally, a partial report paradigm was used to compare iconic memory performance between synaesthetes and non-synaesthetes. Overall, our results provide new evidence for a recognition and short-term memory performance advantage in synaesthesia, but not for an iconic memory performance advantage. They also reveal a priming effect for words judged as new in the CID-R (i.e. correct rejections minus misses) for the controls, but not for the synaesthetes. However, presentation mode does not seem to influence synaesthetic modulation of short-term memory performance. Collectively our results shape a new understanding of the interaction between perceptual features of synaesthesia and memory processes.
**fMRI analysis of the "right" and "wrong" colours in grapheme-colour synaesthesia**

Cassandra Gould\textsuperscript{1,2}, Jamie Ward\textsuperscript{1,3}, Dan Bor\textsuperscript{1,2}, & Anil Seth\textsuperscript{1,2}

\textsuperscript{1}Sackler Centre for Consciousness Science, University of Sussex, Brighton, UK  
\textsuperscript{2}Department of Informatics, University of Sussex, Brighton, UK  
\textsuperscript{3}School of Psychology, University of Sussex, Brighton, UK

Grapheme-colour synaesthetes frequently experience perceptual dissonance when the colouring of an externally presented letter is not aligned with their own synaesthetic colour. We sought to identify the neural mechanisms underlying this synaesthetically-induced perceptual dissonance, in order to better understand the neural basis of synaesthesia-induced sensory experience. We report first results from a large fMRI investigation in which subjects (n=20 synaesthetes) passively viewed blocks of inducing and non-inducing graphemes coloured either black, the same as (congruently) or different (incongruently) to their synaesthetic colour. Subjects were instructed to internally verbalise the name of the grapheme with no overt motor or verbal response. We tested both “projector” and “associator” synaesthetes and correlated their sub-type score across a number of measures with experimental results. By avoiding overt responses, our design extends previous Stroop-like experiments in which activations reflecting motor conflict may have confounded effects of perceptual dissonance. Subjectively, incongruent conditions were experienced as “annoying” or made the subject “angry”, whilst congruent conditions were experienced as “soothing” or “a treat”. Statistical analysis of the interaction between congruency, synaesthetic experience and external colouring has enabled investigation of brain regions involved in the simultaneous processing of both synaesthetic and veridical colouring. We also examine how the perceptual and affective components are modulated by the nature of the synaesthetes’ colour experience.
Look ear! Learning to use a visual-to-auditory sensory substitution device

David J. Brown & M.J. Proulx

Queen Mary University of London, London, UK

Sensory substitution is often described as a form of synthetic synaesthesia in which information from an impaired modality (usually vision) is transmitted to cortical areas via an unimpaired modality (sound or touch). They therefore may be used to facilitate functioning in people with sensory loss. One visual-to-auditory sensory substitution device, The vOICe (Meijer, 1992) converts visual features (brightness, spatial position) into auditory features (amplitude, pitch, and time). Whilst efficacy has been demonstrated for both object recognition and localisation using the vOICe the neural basis and how we learn to use the device is still unclear. Adapting an established unimodal paradigm we tested sighted blindfolded participants in an interval discrimination task using a sonified visual image. Three groups, varying in number of training days, were trained on a specific monaural temporal interval (90ms, 1khz) and then tested on 3 novel alternate stimuli (interval, frequency and binaural input) to try to ascertain which features of the conversion algorithm were driving the generalization and when on the time course paradigm this learning transfer occurs. Results indicate rapid specific perceptual learning to the trained stimulus and a significant trend for generalization to both the untrained frequency (as found in the auditory paradigm) and untrained temporal interval (novel) for the longest 10-day training group. The implications of these results are twofold. From a practical perspective, the temporal lag between specific and generalized perceptual learning informs on the development of training protocols for effective use of sensory substitution devices. From a theoretical basis, generalization to the untrained interval suggests that whilst the signal from the device is in essence auditory it is processed in a multimodal manner.
Mirrored Taste and Mirrored Smell

Alireza Ilbeigi, Sean Williams, Adrian L. Williams, & Noam Sagiv

Department of Psychology, School of Social Sciences, Brunel University, London, UK

The mirror neuron system acts as a neural bridge between self and others. It facilitates the understanding of others’ actions by simulating those actions and recruiting neural circuitry required for producing the observed actions. However, understanding other is not limited to actions. We may also simulate other people’s perceptual experiences. For example, in mirror-touch, observing another person being touch activates the observer’s somatosensory cortex. Inspired by these observations, we ran two experiments to find out whether such phenomena occur in two other senses: taste and smell. The first study was focused on the interactions of visual and gustatory modalities in non-synaesthetes. Using functional MRI, we found that watching videos of other people eating activates the gustatory cortex. In the second experiment, olfactory cortex activations were found in non-synaesthetes while they watched videos of other people smelling objects. We argue that mirroring of perceptual experiences is not restricted to the tactile domain; it extends to the gustatory and olfactory processing as well. Our results are in line with recent studies demonstrating similarities in the underlying brain mechanism(s) between synaesthetes and non-synaesthetes. We hypothesize that in mirror-taste and mirror-smell synaesthetes, such activations are strong enough to cross the threshold of awareness and give rise to a vivid taste or smell experience.
The Ambiguous Synaesthesia of Olivier Messiaen

Solange Glasser

University of Paris IV Sorbonne & Municipal Conservatorium of Music, Paris, France

Born in 1908, French composer Olivier Messiaen showed prodigious musical capacities at a very young age, and became aware during his early adolescence of his ability to "see" music. While he understood that his ability to see coloured notes and chords was not common, he none the less persisted in meticulously writing and describing in detail the colours that he experienced in his compositions, including them as authentic aspects of his music. However, the question of the authenticity of this presumed idiopathic Synaesthesia remained. Did his research into sound-colour correspondences stem from a case of idiopathic synaesthesia, or was he simply a child of his time: an époque rich in experiments searching for a confluence of the arts, which nourished his creative genius and extraordinary capacity for synthesis? There is a third possibility: that of an induced, but decisively acquired Synaesthesia, provoked by extreme environmental conditions during the second world war, which in his case may have triggered synaesthetic hallucinations. Studying the case of Messiaen has given us the chance to explore the effects of his presumed Synaesthesia on his compositional style and objectives, as well as posing the question as to the role that this presumed Synaesthesia may have played in the development of his creative genius, and of his extraordinary ability to synthesize and juxtapose disparate elements within his works. In using Messiaen as an example, it is possible to consider that this metaphoric capacity is perhaps one of the keys to the understanding of creativity in general.
**Girl in motion (film presentation)**

Phil Bowman

Girl In Motion tells the story of a twenty-something girl with synaesthesia living in London. To help her through the trials of dating and living in a big city, she sometimes relies on her synaesthesia to guide her through.

Written and directed by Phil Bowman, produced by Matt Lawson (Downton Abbey) and starring Amy De Bhrún, the film was self-funded by the writer/director and producer and was made over a period of 4 days in early March.

According to director Phil Bowman the original idea for ‘Girl in Motion’ came from writing a few quite separate scenes about a girl in her mid-twenties living in London. Having left university with a degree in Psychology and a head full of interesting studies and research, I often explore the human condition and behaviour through my stories. In the case of this film the lead character has synaesthesia; a condition where perception in one sense sets off sensation in another. Synaesthesia became both another medium for exploring the character of the girl, whilst also being a storytelling device in itself.

The synaesthesia effects were handled by motion designer Blake Neale, whose day-to-day work involves designing graphics for television promos. The subtle grade was provided by colourist Garry Maddison at Prime Focus, whilst the sound post-production was carried out by a team led by mixer Joe Maher at De Lane Lea.

For me, ‘Girl in Motion’ is my homage to minimalist, character-driven cinema, which also taps in to my love of Psychology.

More information about the film can be found here:

http://www.girlinmotionfilm.com

And here are some reviews of the film:


http://www.littlewhitelies.co.uk/blog/grass-roots-girl-in-motion-15658

http://emma-farley.tumblr.com/post/9088470560/i-had-the-pleasure-of-being-able-to-see-the-short

Poster Presentation Abstracts

Do synaesthetic graphemes and colours bind unconsciously?

Hazel Anderson\textsuperscript{1,2}, Ryan Scott\textsuperscript{1,2}, Zoltan Dienes\textsuperscript{1,2}, Anil Seth\textsuperscript{1,3}, & Jamie Ward \textsuperscript{1,2}

\textsuperscript{1}Sackler Centre for Consciousness Science, University of Sussex, Brighton, UK
\textsuperscript{2}School of Psychology, University of Sussex, Brighton, UK
\textsuperscript{3}Department of Informatics, University of Sussex, Brighton, UK

Grapheme-colour synaesthesia is when letter, number or symbolic inducing stimuli simultaneously evoke a concurrent colour experience. Evidence suggests that attention and conscious perception to the inducing stimulus is necessary for the full generation of the concurrent, however it is not yet known whether the inducing grapheme and colour could bind pre-consciously to aid conscious perception. To address this question, we used continuous flash suppression (CFS) to present a dynamic Mondrian pattern to one eye and a grapheme to the other, so that the grapheme remains below conscious threshold an extended time prior to ‘breaking through’ into consciousness. Since genuine colour is known to facilitate break-through under CFS, we reasoned that graphemes which evoke synaesthetic colour would be perceived more quickly than those eliciting synaesthetic monochrome experiences. Experiment 1 tested this hypothesis by presenting inducing graphemes in black font to determine whether those graphemes with colour concurrents would aid breakthrough. We also wondered whether graphemes presented in a synaesthetically congruent colour would break through faster than those presented in an incongruent colour. In experiment 2, coloured graphemes were presented either in their congruent or incongruent colours. Neither the colourfulness of the synaesthetic colour or the congruency of it significantly affected the length of time till it was consciously perceived. These results suggest that the grapheme and colour do not bind pre-consciously, which would be in line with previous research demonstrating that consciously attending to a grapheme is necessary to fully trigger the synaesthetic concurrent.
I saw that coming: Expected touch and internal imagery in mirror-touch synaesthesia

Marc Bloomfield & Mary Jane Spiller

School of Psychology, University of East London, London, UK

Mirror-touch synaesthetes report feeling tactile sensations when they observe others being touched. Research on mirror-touch synaesthesia has thus far focused only on completed touch motion. The current study has expanded this to assess whether presentation of incomplete touch motion may be sufficient, as studies in internally generated imagery in grapheme-colour synaesthetes and in brain responses to expected touch suggest. A variation on Banissy and Ward’s (2007) behavioural protocol was used, with visual stimuli (trial types) varied to show motion to touch ending in touch, no touch or a blank screen. Results for 1 synaesthete (compared to 5 non-synaesthete controls) showed significant effects of trial type and congruency between touch and visual stimuli on response times. This suggests that a mirror-touch synaesthetic response may occur without presentation of actual touch provided the touch is expected or implied. The mechanisms by which this happens remain unclear and possible explanations will be discussed in relation to existing literature.
It feels like it’s me: Interpersonal multisensory stimulation enhances somatosensory mapping of shared tactile stimuli

Flavia Cardini¹, Ana Tajadura-Jimenez¹, Andrea Serino², & Manos Tsakiris¹

¹Lab of Action & Body, Department of Psychology, Royal Holloway, University of London, London, UK
²Centro studi e ricerche in Neuroscienze Cognitive, University of Bologna, Bologna, Italy

We constantly feel, see and move our body, and have no doubt that it is our own, distinct from the body of other people. At the same time, understanding other people’s feelings in social interactions depends on the ability to map onto one’s own body the observed experiences on the bodies of others. It has been shown that the more similar others are perceived to be to our self, the stronger this mapping is. While previous studies have focused on existing similarities or differences between self and other, we ask whether the experimental change of the self-other boundaries can lead to changes in somatosensory processing. It has been shown that the perception of tactile stimuli on the face is enhanced if participants concurrently observe a face being touched. This Visual Remapping of Touch (VRT) is significantly stronger when viewing one’s own face as compared to that of another individual. We used the enfacement illusion that relies on synchronous interpersonal multisensory stimulation (IMS) to manipulate self-other boundaries. Following synchronous, but not asynchronous IMS, the self-related enhancement of the VRT effect was extended to the other individual. These findings suggest that shared multi-sensory experiences represent one key way in which the boundaries and perceived similarity between self and others can be overcome, as evidenced by changes in somatosensory processing of shared tactile stimuli.
Effects of non-symbolic numerical information suggest the existence of magnitude-space synaesthesia

Limor Gertner, Isabel Arend & Avishai Henik

Department of Psychology & Zlotowski Center for Neuroscience, Ben-Gurion University of the Negev, Beer-Sheva, Israel

In number-space synaesthesia, numbers are visualized in spatially-defined arrays. In a recent study (Gertner et al., in press) we found that the size congruency effect (SiCE) for physical judgments (i.e., numerical value was irrelevant) was modulated by the spatial position of the presented numbers. Surprisingly, we found that the neutral condition (i.e., 3 3) was affected as well; that is, when the position of physical sizes matched the synesthetic number-form, synaesthetes performed faster and more accurately than when the position of physical sizes did not match. This pattern gave rise to the idea that number-space synaesthesia might entail not only discrete, ordered, meaningful symbols (i.e., Arabic numbers) but also continuous non-symbolic magnitudes (i.e., sizes, length, luminance, duration, etc.). We tested this idea by assessing the performance of a group of number-space synaesthetes (and matched controls) in 3 comparative judgment tasks involving symbolic and non-symbolic stimuli: (i) Arabic numbers, (ii) patterns of dots and, (iii) sizes of squares. The spatial position of the presented stimuli was manipulated to be compatible or incompatible with respect to the synesthetic number-form. Preliminary results revealed that for synaesthetes, but not for controls, non-symbolic magnitudes (patterns of dots and sizes of squares) as well as symbolic magnitudes (i.e., Arabic numbers) interacted with space. Our study suggests that number-space synaesthetes might have a general magnitude-space association that is not restricted to concrete symbolic stimuli. These findings are discussed in light of theories on the perception and evaluation of sizes in numerical cognition.
Musical shapes on breathing walls: Psychedelic synaesthesia

David Luke¹ & Devin Blair Terhune²

¹Department of Psychology & Counselling, University of Greenwich, London, UK
²Department of Experimental Psychology, University of Oxford, Oxford, UK

The neurobiology of synaesthesia is receiving growing attention in the search for insights into consciousness, such as the binding problem. One way of decoding the neurocognitive mechanisms underlying synaesthesia is to investigate the induction of synaesthesia via neurochemical agents, as commonly occurs with psychedelic substances. How synaesthesia is affected by drugs can also help inform us of the neural mechanisms underlying this condition. References to the occurrence of synaesthesia under the influence of psychedelics abound in the literature, but there is a paucity of research on this topic. To address this lacuna we surveyed a sample of recreational drug users regarding the prevalence, type and frequency of synaesthesia both with and without psychedelics and other psychoactive substances. Results from 410 respondents completing the online survey indicated that, of 28 common psychoactive drugs, the reported consumption of psilocybin, LSD and MDMA/ecstasy all significantly predicted chemically induced synaesthesia experiences. The classic tryptamine psychedelics (primarily serotonergic), particularly LSD (64%), ayahuasca (57%) and psilocybin (52%), induced synaesthesia among those reporting their use more than other substances, with phenethylamine psychedelics (e.g., mescaline, MDMA) and NMDA-antagonist dissociatives (e.g., ketamine, DXM) having effects in 25-32% of those reporting their use. In contrast, tobacco (2%) and Valium (3%) had the least reported effects. Sound-colour (20-30%) and sound-shape (14-26%) synaesthesias were the most commonly reported types with tryptamines, whereas grapheme-colour synaesthesia was more typical for congenital synaesthetes. We will consider these results in the context of different theories of synaesthesia.
Visual search in synaesthesia: Are there synaesthesia-specific redundancy gains?

Beat Meier¹, Nicolas Rothen², Alain Chavaillaz³ & Joseph Krummenacher³

¹University of Bern, Bern, Switzerland
²University of Sussex, Brighton, UK
³University of Fribourg, Fribourg, Switzerland

The goal of the present study was to test whether grapheme-colours synaesthesia would provide for an advantage in visual search. A group of synaesthetes and non-synaesthete control-group were tested with two different visual search tasks, in which they had to detect the presence of a target stimulus in a five by five stimulus grid. The target was defined by its form, or as a particular digit. Thus, in the former condition the targets were defined in one dimension, in the latter condition the targets were defined in one dimension for the control group, but redundantly in two dimensions (form and colour) for the synaesthetes. We hypothesized that if synaesthesia occurs at an early processing stage and does not require visual attention, synaesthetes would have an advantage in the digit condition in which a target digit (i.e., 2) had to be detected amongst similar distractors (i.e., 5) because these stimuli typically elicit a colour experience in synaesthetes, but not in controls. However, the results revealed no performance advantage for synaesthetes. Thus, it seems that synaesthesia requires time-consuming attentional processing of a stimulus to induce a synaesthetic experience which would then be a prerequisite for a performance advantage.
Visualmusic brain: pilot study on the relationship between the primary visual cortex, mental imagery and synesthetic experiences

Giuseppe Passalacqua, Barbara Colombo, Guglielmo Pugliesi, & Chiara Di Nuzzo

Department of Psychology, Catholic University of Sacred Heart, Milano, Italy

This pilot study aims to investigate the relationship between mental imagery and synaesthesia that occurs while listening to music, on the assumption that the link between music and mental images can be explained by processes involving intermodal different areas of the brain, particularly the auditory and the visual cortex. Using tDCS (transcranial direct current stimulation) the primary visual cortex (V1) was inhibited, working with a sample of musicians and non-musicians. This allowed us to investigate its specific role while listening to music. Additional variables were the level of spontaneous use of mental imagery and synesthetic abilities. Finally, eye-tracking technology was used to record behavioural indices of visual exploration while listening to music, which can be linked to mental visualization processes. Results showed that musical expertise and inhibition of V1 affect synesthetic experience and mental imagery while listening to music. In addition, the analysis highlighted the role of specific individual differences (in particular the tendency to use mental images and personality trait linked to imagination) during cognitive and synaesthetic processing of complex musical stimuli.
Focusing the mind’s eye: Grapheme-colour synaesthesia from imagining explicit and implicit letter properties

Ceydan Serinsu & Mary Jane Spiller

School of Psychology, University of East London, London, UK

Grapheme-colour synaesthesia can be described as the condition whereby letters and numbers are associated with the experience of colours. Previous research has suggested that for some synaesthetes the colour concurrent can be elicited from a mental image of a grapheme. The current study further explores this idea by looking at whether the level of detail required by the imagery tasks affects the synaesthetic experience. Grapheme-colour synaesthetes (N=2) and matched controls (N=5 per synaesthete) completed a mental imagery task that involved forming visual mental images of graphemes, and deciding whether each letter had certain implicit (e.g. the enclosed space in the letter B) or explicit properties (e.g. the curved line in the letter S). The background colour each grapheme was visualised against was either congruent or incongruent to the synaesthete’s visual experience of the grapheme. A low-attentional task was also conducted to ensure that background colour was attended to during task performance. A colour congruency effect was expected for synaesthetes’ task performance, and this could also interact with level of detail required. Only an effect of level of detail was expected for the non-synaesthetes. Results will be discussed in light of previous research, and the implications for our understanding of grapheme-colour synaesthesia.
Working Memory and Executive Functions in Synesthesia

Tünde Sipka, Dezso Nemeth

Institute of Psychology, University of Szeged, Hungary

The aim of our study was to investigate working memory and executive functions in synesthesia in order to determine how synesthesia effects the short-term and working memory processes. The synesthetic group consisted of fourteen adults who have grapheme-color synesthesia. The control group was matched in age, sex and education. We used the following tasks: Wisconsin Card Sorting Test, Stroop, Digit Span, Backward Digit Span, Corsi Block Tapping Task. Our results show significant differences between the two groups in the performance on Digit Span, Backward Digit Span and Corsi Block Tapping Tasks. Our results suggest that the visual coding of verbal stimuli can boost the memory and control functions.
Is self-projection the key to understanding the attribution of agency to graphemes in sequence-personality synaesthesia: A neuroimaging study

Monika Sobczak, Adrian Williams, & Noam Sagiv

Centre for Cognition and Neuroimaging, Brunel University, London, UK

In sequence-personality synaesthesia letters and numbers are perceived as having such human qualities, such as personality traits, gender, profession, mental states and relationships between each other. The biographical and social characteristics of letters and numbers suggest links between the cognitive stream processing graphemes and general social cognition mechanisms for understanding others. Could it be the case that in sequence-personality synaesthesia, representations of mental states can be activated not only when interacting with or thinking about humans but also when pondering non-human concepts such as graphemes? One of the theoretical approaches for understanding minds of others suggests that people use a self-projection mechanism to understand the mental states of others (in the Taking into account the social character of personified letters and numbers, we hypothesize that sequence-personality synaesthesia relies on a common self-projection mechanism for "mindreading" used in everyday social cognition. Here, we will present the results of a new functional neuroimaging study of grapheme personification that examines this hypothesis at the neural level.
Posthypnotic manipulation of the visuospatial phenomenology of colour photisms modulates selective attention in synaesthesia

Devin Blair Terhune & Roi Cohen Kadosh

Department of Experimental Psychology, University of Oxford, Oxford, UK

Individuals with grapheme-colour synaesthesia vary in the perceived visuo-spatial location of concurrent colour photisms with some experiencing photisms as mental images or representations (associators) and others experiencing them as percepts that are spatially proximal to inducer stimuli (projectors). Previous studies have suggested that this typological variability can account for individual differences in interference effects in stimulus and photism colour-naming variants of the synaesthesia Stroop task, but this has yet to be directly tested because the visuo-spatial location of colour photisms has not yet been subjected to experimental manipulation. In this experiment we induced synaesthesia in highly suggestible non-synaesthetes (‘virtual’ synaesthetes) and experimentally manipulated the visuo-spatial location of synaesthetic colour photisms using posthypnotic suggestion. Congenital and virtual associator and projector synaesthetes completed stimulus and photism colour-naming variants of the synaesthesia Stroop task in a between-groups design. The visuo-spatial location of concurrent colour photisms modulated interference effects in both congenital and virtual synaesthetes, with projector synaesthetes displaying greater stimulus, but not photism, colour-naming interference effects than associator synaesthetes. These results provide experimental evidence for a close coupling of visuo-spatial photism phenomenology and behavioural interference effects in grapheme-colour synaesthesia.
**Time-Space Synaesthesia and Cognitive Advantages**

Andrea Wantz & Beat Meier  
*Department of Psychology and Center for Cognition, Learning and Memory, University of Bern, Switzerland*

Time-space synaesthetes perceive visuo-spatial arrangements for different units of time. Previous findings suggest that time-space synaesthesia is associated with cognitive advantages in a task requiring mental operating with months. The aim of the present study was to investigate whether this advantage is also present in a task involving operations with days. Eight time-space synaesthetes and eight age-, sex- and education-matched controls participated in the study. The task consisted of time operations such as “two days before Saturday: Thursday”, both including day and month operations. Participants were asked to judge as fast and accurate as possible if the presented time calculations were correct. The results showed that synaesthetes responded significantly faster than controls in both conditions. Hence, these results extend previous findings. They demonstrate that cognitive advantages in time-space synaesthetes are not restricted to mental operations with months.