Can Tracking Representationalism Make Sense of Synesthesia?

CAN TRACKING REPRESENTATIONALISM MAKE SENSE OF SYNESTHESIA?

by

CASEY L. LANDERS

Under the direction of Dan Weiskopf, Ph.D.

ABSTRACT

Synesthesia is a neurological phenomenon in which a single stimulus typically associated with one sensory modality automatically and involuntarily produces sensations not typically associated with that modality. I argue that synesthesia elucidates how two naturalistic theories of representation and phenomenal experience conflict. Strong representationalism holds that what an experience is like is determined by the experience's representational content. Informational semantics holds that representational content is determined by causal co-variation between a representation and an external object or property. I argue that according to informational semantics, synesthetes and normal perceivers represent the same content in different ways. However, according to strong representationalism, two experiences with the same content must be represented in the same way. Therefore, if strong representationalists want to account for synesthesia, they cannot hold onto informational semantics as a theory of mental content.

INDEX WORDS: Synesthesia, Strong representationalism, Informational semantics, Representational content, Phenomenal character, Causal co-variation, Perceptual experience

CAN TRACKING REPRESENTATIONALISM MAKE SENSE OF SYNESTHESIA?

by

CASEY L. LANDERS

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Masters of Arts

in the College of Arts and Sciences

Georgia State University

2015

CAN TRACKING REPRESENTATIONALISM MAKE SENSE OF SYNESTHESIA?

by

CASEY L. LANDERS

Committee Chair: Dan Weiskopf

Committee: Neil Van Leeuwen

Eddy Nahmias

Electronic Version Approved:

Office of Graduate Studies

College of Arts and Sciences

Georgia State University

May 2015

ACKNOWLEDGEMENTS

I would like to thank many people for their helpful conversations and comments on this project. First, I would like to thank my advisor, Dan Weiskopf, who always charitably answers and clarifies my opaque questions and inchoate thoughts, and who has seen countless drafts of this thesis. Thanks to Neil Van Leeuwen, who helped immensely with the structure and presentation of the project. I'd like to thank Eddy Nahmias for many rounds of useful advice and pressing questions on previous drafts. Thank you to David DiDomenico for our innumerable philosophical conversations about perception. Finally, I'd like to thank my fellow colleagues—Dan Mendez, Rob Boudreau, Gerald Taylor, Jay Spitzley, and Maria Mejia—who participated in a writing workshop and offered insightful comments and suggestions on a previous draft.

TABLE OF CONTENTS

LIST OF FIGURES

1 INTRODUCTION

Synesthesia is a neurological phenomenon in which a single stimulus typically associated with one sensory modality automatically and involuntarily produces sensations not typically associated with that modality. For instance, sounds or letters may elicit color sensations, or tastes may elicit tactile sensations. Synesthesia is philosophically interesting for many reasons. To name a few, it raises questions about modularity, the individuation of and relation between the senses, and functionalism. In this paper, I'll focus on synesthesia because it exposes a tension between two seemingly complementary theories: strong representationalism and informational semantics. Strong representationalism holds that the phenomenal quality of experience—what experience is like from the first person perspective—is fully determined by what is represented in experience. For example, a *representation of blueness* fully determines the phenomenal property *what-it-is-like to see blue*. Informational semantics holds that the content of a representation is that with which the representation causally co-varies. For example, a *representation of blue* has the content it does because that representation causally co-varies with the property *blueness*.

On the face of it, representationalism and informational semantics go hand in hand: both offer naturalistic accounts of facets of our mental lives that often seem inexplicable. Representationalism attempts to reduce phenomenology to intentionality. That is, it explains how phenomenology is representational. Informational semantics attempts to explain intentionality in terms of causal co-variation, i.e., a tracking relation between a representation and some external, physical property or object. Holding these theories in conjunction, a view that is sometimes referred to as 'tracking representationalism', offers a plausible way to explain the phenomenal quality of experience in terms of physical properties. In other words, tracking representationalism attempts to give a satisfying account of both phenomenal experience and

representation by reducing the former to the latter, and the latter to physical properties. Thus, tracking representationalism is an attractive reductive physicalist theory of the mind.[1]

I argue that the phenomenon of synesthesia poses a problem for tracking representationalism. According to informational semantics, synesthetic and normal perceptual representations can share the same content but differ in their phenomenal character because, as I demonstrate below, two experiences with different phenomenal characters can share the same tracking function. This is problematic for tracking representationalism. Insofar as representationalism holds that phenomenal character just *is* representational content, two experiences with different phenomenal characters must also differ in what they represent.[2] Therefore, synesthesia reveals that holding onto both informational semantics and representationalism, i.e., tracking representationalism, is untenable.

The structure of this thesis is as follows. In the first section, I make some preliminary remarks about the terms I use, some motivations for representationalism, the debate between representationalists and anti-representationalists, and how my project will contribute to the debate. Section Two explores the phenomenon of synesthesia and provides empirical support for the claim that the best interpretation of synesthetic experience is that it is a genuine perceptual phenomenon. In Section Three, I discuss what informational semantics is. Section Four shows that synesthesia meets all of the conditions for accurate representation according to informational semantics, and further, that synesthetes and normal perceivers represent the same content. Section Five illustrates how explaining synesthetic perception in the light of informational

---

[1] Defenders of tracking representationalism include Dretske (1995), Lycan (1996), and Tye (1995, 2000).

[2] There is a distinction between strong and weak representationalism. Weak representationalism does not claim that phenomenal character and representational content are identical. I discuss this distinction in the next section.

semantics is problematic for tracking representationalism. In the penultimate sections, I discuss two potential ways tracking representationalists might respond and then show why both avenues are problematic.

2 PRELIMINARY REMARKS

Perceptual experiences are often analyzed as having two parts: an intentional component, their representational content, and a phenomenological component, their phenomenal character. By 'representational content', I mean what the experience represents. When I see my dog in the backyard, the contents of my representation are the perceived qualities of the experience—the outline of my dog, the texture and color of his fur, and so on. These are aspects of the dog that vision represents. By 'phenomenal character', I mean what the experience is like from the first-person perspective. The experience of the color and texture of my dog's fur feels or seems a particular way to me.

Representationalism attempts to explain what phenomenal character is in terms of representational content. There are two versions of representationalism. Weak representationalism holds that phenomenal character supervenes on representational content. According to weak representationalism, if two experiences have different representational contents, then they also have different phenomenal characters. Moreover, there can be two experiences with the same representational contents yet different phenomenal characters. Strong representationalism holds that phenomenal character just is representational content. According to strong representationalism, necessarily, there cannot be two experiences with different phenomenal characters yet the same representational content. Tracking representationalists assume the strong version, and throughout I will use 'representationalism' to refer to the strong version. The distinction between weak and strong forms is especially important to keep in mind when considering counterexamples to representationalism, to which I will turn after a brief discussion of the motivation for representationalism.

Representationalism rests on an intuition concerning the diaphanousness or transparency of experience, notably discussed by G.E. Moore. When we attend to perceptual experience, we

are generally pulled outward, so to speak, and attend to qualities of the objects of experience, and not to qualities of the experience itself. That is, perceptual experience seems transparent—there aren't any intrinsic qualities of the experience that we focus on. Rather, the qualities that we attend to are the qualities of some external object. As Tye (2002) succinctly puts it, "if blueness is one of the qualities and roundness another, you do not experience your experience as blue or round." What experience unveils to perceivers like us is the world and its objects, not facets of the experience itself.

The representationalist thesis is an inference to the best explanation. What explains this transparent feature of experience? The most simple and straightforward explanation is that the way an experience feels from first-person perspective is due to what the objects of experience are like. Phenomenal character just *is* representational content. That's why when we attend to a perceptual experience, we always seem to attend to the represented objects and properties.

Anti-representationalists argue that there is some aspect of the felt quality of experience that is non-representational. That is, they think that phenomenal character and representational content are not the same. To show that phenomenal character isn't reducible to representational content, anti-representationalists raise counterexamples in which perceptual experiences have either different phenomenal characters but the same representational content or the same phenomenal characters but different contents.[3]

Some counterexamples are purely theoretical, like inverted spectra arguments, which present the possibility that two people in the actual world experience inverted color sensations when presented with the same stimulus. For example, Mary might see the tomato as red, whereas John sees the same tomato as green. Moreover, every object Mary sees as red, John sees as

[3] Two experiences with different phenomenal characters and the same representational content is not a problem for weak representationalism since it claims that phenomenal character supervenes rather than reduces to representational content.

green, and every object Mary sees as green, Jon sees as red. Their spectra are inverted with respect to one another. As long as they use the same terms to refer to the same objects, they will never know that their color experiences are inverted. If inverted spectra are possible, then representationalists face a difficulty. Both Mary and John represent the same surface spectral reflectance, yet each of their experiences has a different phenomenal character. The problem with inverted spectra arguments against representationalism is that representationalists simply deny their possibility.

More popular counterexamples invoke actual normal perceptual scenarios, like looking down dark tunnels with one eye versus two eyes open, seeing blurry things clearly versus seeing clear things blurrily, and viewing a coin from different angles.[4] Take, for example, looking down a dark tunnel. With both eyes open, you experience darkness all around and a bright light in the distance. Close one of your eyes and nothing seems to change. You still seem to be representing darkness all around with a bright light in the distance. But, importantly, the experience feels different, in that you experience more of the dark tunnel. These two experiences—viewing the tunnel with both versus one eye open—seem to constitute a counterexample to representationalism, insofar as the two experiences seem to represent the same content yet have different phenomenal characters.

However, the representationalist has a fairly simply way to respond. There is a genuine difference in content between the one eye versus two eye tunnel viewing experiences. When you close one eye, you are representing less stuff—there is less stuff in your visual field, hence the difference in phenomenal character. Generally speaking, anti-representationalists run into this objection—no matter the proposed counterexample, representationalists always seem to find a

[4] See (Tye 2003) for an in-depth discussion of each of these proposed counterexamples and how the representationalist can respond.

difference in content between two proposed experiences that on the face of it seem to represent the same thing but have different phenomenal characters, as in the tunnel viewing case.

Another often cited counterexample involves a familiar perceptual experience (at least for some)—upon removing your prescription eyeglasses, your vision becomes blurry. The object you were glancing at before now looks different, but it doesn't look to have changed per se (Boghossian and Velleman 1989). The anti-representationalist claims that the experience does not represent the object to be blurry. Rather, what has changed is something about the experience—a property of the experience itself. Representationally, the two experiences—the "clear" experience of the object with your glasses on, and the "blurry" experience of the object with your glasses off—are the same in that they both represent the same object. However, there is a glaring difference (blurry vs. clear vision) between the phenomenal characters of the two experiences.

The representationalist has a response on hand, namely that what accounts for the phenomenal difference between the two experiences is a loss of information (Tye 2003). When you take off your glasses, you undergo sensory representations that fail to specify just where the boundaries and contours lie… the grouped array contains less definite information about surface depth, orientation, contours, etc." (714). Therefore, the blurry vision experience represents less information, which accounts for the phenomenal difference between it and the clear vision experience.

Cross-modal cases that involve perceiving the same object through different modalities have also been proposed as counterexamples to representationalism. For instance, I may have a visual experience and a tactile experience of a water bottle. In both experiences, I represent the water bottle, yet there is a striking difference between the visual and tactile sensations. Here, one

might think, is a plausible counterexample to representationalism. Nonetheless, the representationalist can point to an overlooked difference in content: the tactile sensation involves the shape of the water bottle *and* a sensation of coolness that is not present in the visual sensation, whereas the visual sensation involves the shape of the bottle *and* a sensation of blueness. Therefore, the tactile and visual experiences have overlapping content, namely the water bottle and its shape, but each experience also represents some additional content that the other does not represent.

In this thesis, I present a counterexample to a specific version of representationalism, namely tracking representationalism.[5] I argue that if representationalists want to account for synesthesia (and they should because it is an empirically confirmed neurological phenomenon), then they cannot hold informational semantics as a theory of content. I do this by showing that applying informational semantics to synesthesia presents a challenge to representationalism. Therefore, my argument narrows the kinds of theories of content representationalists can hold. Given that many representationalists need a theory like informational semantics in order to complete the reduction of phenomenal character to representation and representation to physical properties, this argument poses an important question for how to be a tracking representationalist. Next I turn to a discussion of what synesthesia is and present some empirical data that strongly support that it is a genuine phenomenon, i.e., that the reported cross-modal experiences are not merely hyperbolic metaphorical associations, but rather have a distinct perceptual and neurological basis.

[5] Wager (1999) also proposes synesthesia as a counterexample for representationalists who assume informational semantics. Although I mostly agree with his analysis, in spirit if not in letter, I develop my argument differently than his in section 4, and in section 5 I discuss in more detail the different ways the tracking representationliast can respond.

3 IS SYNESTHESIA A GENUINE PHENOMENON?

The first medical documentation of synesthesia comes from the German physician Sachs in 1812, with Gustav Fechner and Francis Galton studying the phenomenon later in the 19th century. These early investigations of synesthesia mainly focused on the detailed introspective reports of synesthetic experiences. However, partially due to the reign of behaviorism starting in the 1930s and its associated denial of the method of introspection, there was a lack of scientific interest in synesthesia for much of the 20th century. Serious inquiry didn't begin to take place until the 1980s. Although current scientific investigations of this phenomenon include more than introspective reports, (some of which I discuss below,) our understanding of synesthesia is still quite inchoate.

For example, we still don't have a firm grasp on synesthesia's prevalence in the general population. Some estimates claim 1 in 20,000 people have synesthesia, (Cytowic 1989) while other estimates are more generous at 1 in 200 (Ramachandran and Hubbard 2001). Many researchers agree that synesthesia is genetic (Galton 1880; Baron-Cohen et. al. 1996). However, not all cases of synesthesia have a genetic basis. Although it seems that the majority of reported cases are congenital, some cases of synesthesia are acquired. For instance, head trauma can induce acquired synesthesia.[6] Moreover, synesthetic-like experiences have been reported in drug-induced hallucinations.

Perhaps the least understood and most pressing aspect of synesthesia concerns its neural basis. Currently researchers are divided on what the neurological underpinnings are. Ramachandran and Hubbard (2001) propose the Cross-Activation Hypothesis, which claims that synesthesia arises from a cross wiring of different brain regions that perform different functions. Early in life, the brain is hyper-connected and the superfluous connections are pruned throughout

[6] See Brogaard et. al. 2012 for an interesting case of acquired mathematical synesthesia.

development. According to the Cross-Activation Hypothesis, synesthesia arises when these superfluous connections are not pruned away. Due to this cross wiring, when Area 1 is activated, Area 2 is also activated. If Area 1 is associated with, say, sound processing, and Area 2 is associated with color processing, then the cross-activation explains why synesthetes experience a color sensation when there is sound input. The Cross-Activation Hypothesis finds empirical support in the facts that 1) the most common form of synesthesia is grapheme-color, and 2) visual grapheme and color areas are anatomically adjacent in the fusiform gyrus.

The Disinhibited Feedback Hypothesis is sometimes posed as an alternate explanation of the neural causes of synesthesia, (but the two hypotheses are not mutually exclusive). Sensory information doesn't travel in one direction. Although it travels from primary sensory areas to association areas, sensory information also travels back from higher cortical areas to the early sensory regions in a kind of feedback loop. This feedback loop typically has an array of neural impulses that are inhibited. If this feedback is disinhibited, then later stages of processing could alter earlier ones, which might account for why, say, sound-color synesthetes experience color in response sound: sound information could activate early visual areas like V4 (Grossenbacher & Lovelace 2001).

In addition to disagreement concerning the neural basis of synesthesia, the very definition of the phenomenon is still being disputed. Synesthesia is often defined as a cross-modal experience that occurs when a stimulus associated with one sense modality (the *inducer*) produces a sensation in another modality (the *concurrent*). For instance, sounds can produce color sensations; tastes can produce tactile sensations; colors can produce gustatory sensations, and so on. As far as we know, potentially any two sense modalities can interact in this way.

As is clear from the fact that graphemes are involved in some forms, synesthesia is not strictly limited to sense modalities: lexical and numerical categories and time units, like days of

the week, are sometimes inducer stimuli. Therefore, some propose we should adopt a more inclusive definition like the following: Synesthesia is a phenomenon in which stimulation of a sense *or concept* triggers a sensation not normally associated with the stimulus.[7] With this working definition, 61 different inducer-concurrent pairings have been documented (Day 2009), but some pairings appear to be more common than others, like sound-color and grapheme-color forms.

For some time, many questioned whether synesthesia was genuine phenomenon. Some proposed that the cross-modal sensations were just products of over-active imaginations. Indeed, given how strange synesthetic reports sound to normal perceivers, a skeptic may think that synesthetes are simply "making up" their experiences. For instance, she might think that synesthesia is merely a metaphorical association between modalities or sensations. However, an array of empirical evidence suggests otherwise. One piece of evidence that suggests synesthetes aren't just making up their experiences is that synesthetic reports are typically highly consistent over time compared to control groups (normal perceivers). Baron-Cohen, Wyke, and Binnie (1987) studied a synesthete, E.P, who experienced color in response to spoken language. She described what colors she experienced in response to over 100 different stimuli and, ten weeks later, she was retested. Her responses to the stimuli were exactly the same. The researchers also tested a non-synesthete, whose answers only two weeks later were 17% consistent with the initial responses. This consistency and stability between the inducer and concurrent is now considered a hallmark of synesthesia (Cytowic 2002).

A second piece of evidence that suggests synesthesia is a genuine phenomenon is that there is increased activation in brain areas associated with the concurrent sensation in the synesthetic brain (Brang et al. 2010; Hubbard et. al. 2005; Sperling et al. 2006). For example,

[7] This definition is modified from Novich, Cheng, & Eagleman (2011).

when presented with graphemes, grapheme-color synesthetes show greater activation in early retinotopic visual areas (V1, V2, V3, V4) than non-synesthetes (Hubbard et. al. 2005). However, one might worry that grapheme-color synesthetes are merely imagining color when they are presented with or think about a particular grapheme. The same brain areas associated with perceptual processing are activated when one imagines the same content, so perhaps the synesthete might just be imagining the inducer-concurrent pairings.

Nevertheless, electrophysiological differences between synesthetes and non-synesthetes suggest that synesthetes are not merely imagining the inducer-concurrent pairings. Goller, Otten, and Ward (2009) looked at event related potentials (ERPs), the brain's electrical responses to stimuli, in sound-color synesthetes. They found ERP differences between the synesthetic and normal brain as early as 100 ms after an auditory tone was played. This indicates that sound-color forms reflect earlier, as opposed to later, processes in the brain. Earlier processes are typically automatic, while later processes are typically intentional, like remembering and imagining. Therefore, if synesthetes were merely imagining the concurrent sensations, then we wouldn't expect to find a difference in neural responses 100 ms after the tone was played but rather later in the information processing time span.

Another piece of evidence that suggests synesthesia is a genuine phenomenon is that synesthetes experience 'pop-out'. Ramachandran and Hubbard (2001) presented grapheme-color synesthetes with a picture composed of the numbers '2' and '5'. In the picture, the number '2' was strategically placed multiple times to form a triangle, and the '5's were placed randomly. For the non-synesthetes, finding the shape is difficult since '2's and '5's look similar. However, for the grapheme-color synesthete, the shape is effortlessly recognized given that '2's and '5's are colored differently. Indeed, grapheme-color synesthetes identify the shape much faster than

non-synesthetes, indicating that synesthetes are not merely making up their synesthetic experiences.

Taken together, these results strongly support that synesthetes are not making their experiences up. If they were, then we should expect to find that synesthetic pairings are not highly consistent over time, that areas associated with the concurrent sensation are not activated in synesthetic experience, that there are no significant electrophysiological differences between synesthetes and normal perceivers, and that synesthetes do not experience ‘pop-out’. However, the empirical data indicate just the opposite.

4 INFORMATIONAL SEMANTICS

Having established that that synesthesia is a genuine phenomenon, I now turn to a discussion of informational semantics. Informational semantics is a causal theory of mental content. Causal theories of mental content generally hold that a representation is about some external object insofar as the object causes the representation. According to informational semantics, the representational content of an experience is determined by causal co-variation between a representation and an external object or property. Under this theory, representations are signals or symbols that signify or stand in for something external to the representational system.[8]

There are three conditions a token representation R must meet in order for it to stand in for some kind of external object or property P. The first is the *causal condition*: R and P must have a causal relationship. That is, P-types must cause tokens of R. However, it's not enough for a particular representation to be caused by some kind of external property—that particular representation must always be caused by that kind of external property. This is the second condition, namely the *co-variation condition*: R tokens and P types must *co-vary*. Co-variation is often understood in terms of consistency: P types consistently causes tokens of R. The third is the *normality condition*: P must cause tokens of R *in the right way*, where 'in the right way' refers to optimal or normal conditions. Only the causes of R that take place under normal conditions contribute to the content.

What exactly are normal conditions? Defining what constitutes normal conditions is a fairly tricky endeavor. Philosophers often start explicating the notion with the example of a tree and its growth rings. Growth rings indicate or represent a tree's age—each ring represents a year. When we stumble across a tree stump and count thirty rings, we generally think that the tree was

[8] See Drestke (1981) for the most influential articulation of informational semantics.

thirty years old when it was chopped down. However, trees require a certain amount of rainfall per year for this one ring per year rule to hold. So if there is a severe drought one year, a tree might not grow enough to add a ring. Therefore, the growth rings represent years only if the conditions are normal, namely if there are normal amounts of rainfall every year.

This example shows that only the causes of the tokening of the representation that take place in normal conditions contribute to representational content. In the case of representational systems like the human brain, being in normal conditions would intuitively include not being under the influence of hallucinogenic drugs or being stimulated by microelectrodes. Imagine that I've taken LSD and it looks as though a fox is in the room. Intuitively, the dose of LSD I've ingested is not part of my representation, even though it is a cause of my representation. In order to filter what counts as the content of my representation, the informational semanticist can say that my being under the influence of LSD is not a normal condition, so my FOX representation doesn't represent my ingestion of LSD.[9] In addition, certain environmental conditions would not count as normal, such as bad lighting or far distance (for visual representations). If I see a fox in bad light, from a mile away, or through heavy fog, the tokening of, say my DOG representation would not be in normal conditions, so the DOG representation wouldn't represent foxes (Adams and Aizawa 2010). In other words, normal conditions refer to a stable environment and representational system.[10]

So, for example, if 1) the property of being a dog causes a tokening of the representation DOG, 2) this representation consistently tracks dogs, 4) the tokening of DOG takes place in

---

[9] The reader may think that synesthetic experiences are some kind of hallucination. However, informational semantics has a notoriously difficult task in accounting for non-veridical experiences. In section 8, I'll discuss why. Further, I'll discuss an objection to my argument that attempts to account for synesthesia as a hallucination.

[10] This definition of "normal conditions" is still vague, but it will do as a working definition for now. I will discuss some possible amendments to the definition in section 8.

normal conditions, then the content of the representation DOG is the property of being a dog. All conditions have been met to establish an informational relationship between the representation and the property of being a dog.

An important characteristic of informational semantics is that there is a distinction between the content of a message and how that content is communicated or captured. Think of the sound a doorbell makes.[11] What does it represent? It represents that someone is at the door. The function of a doorbell is to tell us when someone is at the door, and the signal that carries this information is the sound the doorbell makes. The kind of sound the doorbell makes is unimportant as long as it in some way signifies that someone is at the door. In fact, the doorbell needn't make a sound at all in order to signify that someone is at the door—the signal could be carried by other means, such as a red bulb lighting up.

In a similar vein, two perceptual representations needn't have their messages encoded in the same way in order to carry the same content. If two perceptual representations causally co-vary with the same distal stimulus in the right conditions, those two perceptual experiences represent the same property or object. Moreover, they can capture the same content even though their signals are different. The signal in a perceptual representation is the way the experience feels from the first person perspective, and the content of a perceptual representation is the distal stimulus that causally co-varies with the signal.[12] I argue in the next section that despite the phenomenological difference between synesthetic and normal perceptual experiences, both experiences causally co-vary with the same distal stimulus in the right conditions and thus share

[11] This example is taken from Dretske (1981).

[12] As I use the terms, 'sensation' and 'phenomenal character' refer to the way a perceptual experience feels from a first person perspective. Sensation is a particular kind of phenomenal character that's associated with sensory modalities and other bodily feelings like pain. Perhaps there are other types of phenomenal character that are not strictly associated with sensory modalities, e.g., what it feels like to desire chocolate, to believe that 2+2=4, to be sleepy, or to find something disgusting.

the same representational content.

5 WHAT SYNESTHETES REPRESENT

Before I delve into what I think synesthetes represent according to informational semantics, I must clarify the types of synesthesia to which my argument refers. Given the vast heterogeneity of synesthesia, I restrict my argument to specific forms. Indeed, it may not be the case that all forms of synesthesia can work the same way in my argument. For instance, higher synesthetes—those who associate a sensation with some concept, like some grapheme-color synesthetes or those who experience time-units as colored—probably wouldn't work as a counterexample to tracking representationalism. Insofar as the inducer stimulus is a concept as opposed to a percept, informational semantics wouldn't apply since, as it is traditionally construed, the theory applies only to representations that are externally caused via perceptual processes. Therefore, I will use congenital sound-color synesthesia as an example throughout my argument. Other types of congenital synesthesia that involve cross-perceptual representations may work just as well as sound-color synesthesia. Now that I've appropriately restricted my argument to include only certain kinds of synesthesia, I turn to what synesthetes represent.

Synesthetes accurately represent the world according to informational semantics. More precisely, synesthetic representations meet the conditions for being contentful. First, the same stimuli cause both synesthetic and normal representations. Consider the hypothetical example of Jane, a sound-color synesthete who experiences blueness when she hears sound waves traveling at 261.1 Hz, namely Middle C.[13] Middle C causes a sensation of *p*, pitch, and *c,* color, in Jane. That is, the signal tokened in Jane's mind is *p and c*. In the normal perceiver, call him Fred, only *p* is caused by Middle C. Thus, since both Fred's and Jane's representations are both caused by Middle C, their representations meet the *causal condition*.

[13] Wager (1999) also uses the example of a sound-color synesthete who hears Middle C as colored.

Second, synesthetic representations co-vary with the inducer stimulus. Just as *p* is a consistent indicator that Middle C is present for Fred, the occurrence of *p and c* is a consistent and reliable indicator that Middle C is present for Jane. As noted in the second section, consistency is considered a hallmark of synesthesia. The inducer-concurrent relations are typically so stable that the concurrent sensation is a reliable indicator of the inducer stimulus.

An interesting example of how reliable synesthetic representations are: there is a high rate of co-occurrence between absolute pitch (the ability to recognize and name the pitch of a musical note) and sound-color synesthesia. Gregerson *et. al* (2013) found that, among over 700 people with absolute pitch, 20% of that population had sound-color synesthesia. The color sensations experienced in sound-color synesthesia are so reliable and accurate that they allow the bearer to always pick out the correct pitch. Thus, the *co-variation condition* is met.

One might worry that Jane's color representations causally co-vary with two types of properties, namely color and sound ones. Indeed, Jane experiences the color blue when she looks at a basket of blueberries *and* when she hears Middle C. This suggests that her color representations co-vary with color properties and sound properties, which would mean that according to informational semantics, the content of color representations would have to be some kind of conjunction or disjunction of sound and color properties. This would be a strange consequence of applying informational semantics to synesthetic experience, implying that Jane represents more than just color when she looks at a color property. However, we can avoid this worry if we think of the synesthetic representation that is caused by Middle C as a kind of sui generis representation that is some amalgam of sound and color. This sui generis sound-color sensation is tokened in response to sounds—it is the representation that causally co-varies with sound properties. In this way, Jane can still have normal, veridical color experiences (unless she

is a color-sound synesthete as well), because only the color representations causally co-vary with the color properties.[14]

Last, Jane's representation must meet the *normality condition*. As pointed out in the last section, normal conditions broadly construed mean stable conditions. Given that Jane and Fred can be in the same environment yet Jane still experiences cross-modal sensations, we can rule out that there are abnormal environmental conditions. Moreover, Jane's representational system is stable. She has not taken LSD in order to experience her synesthetic sensations. Her synesthesia is congenital—it has been a part of her perceptual representations of the world for as long as she can remember. Moreover, as discussed in the third section, synesthesia is highly consistent over time.

Therefore, synesthetes can represent the same properties as normal perceivers. Despite the bizarre nature of synesthetic reports, both Jane and Fred represent Middle C; they just represent it in different ways, as Figure 1 depicts. Jane's representation is the conjunction or an amalgam of *p and c*, whereas for Fred the representation is only *p*. Both of these representations carry the information that Middle C is present, just as two different sound patterns can carry the information that someone is at the door.

[14] Granted, I've assumed a lot here, namely that synesthetic cross-modal representations are really sui generis. One may push back on this notion and insist that complex representations can be divided into simpler ones, and "divide" the synesthete's cross-modal representation into two discrete ones, namely the inducer representation and concurrent representation. I'll discuss this in section 8.

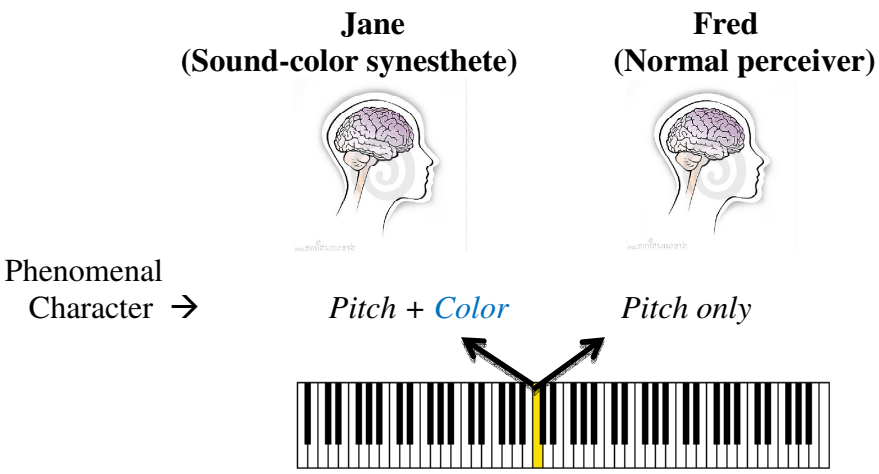

Figure 1 What Synesthetes and Normal Perceivers Represent

6 THE PROBLEM FOR TRACKING REPRESENTATIONALISM

According to informational semantics, the perceptual experiences of Jane, a sound-color synesthete, and Fred, a normal perceiver, share the same representational content. If synesthetes genuinely experience different sensations than normal perceivers, then Jane's experience has a different phenomenal character than Fred's. We have good reason to accept that synesthetes genuinely experience different sensations. So, when informational semantics is applied to synesthesia, the conclusion is that Jane and Fred's experiences represent Middle C with different phenomenal characters. However, according to representationalism, two experiences that share the same representational content must have the same phenomenal characters. Hence, holding onto both representationalism and informational semantics is untenable. Here is the formalized argument, set up as a reductio:

1. Suppose that both informational semantics and representationalism are true.

2. If informational semantics is true, then Jane and Fred's experiences represent the same content yet have different phenomenal characters.

3. If representationalism is true, then it is not the case that Jane and Fred's experiences represent the same content yet have different phenomenal characters.

4. Contradiction: it is and is not the case that Jane and Fred's experiences represent the same content yet have different phenomenal characters.

5. Therefore, it is not the case that both informational semantics and representationalism are true.

7 DIFFERENT MODALITIES MEAN DIFFERENT REPRESENTATIONAL CONTENTS

How might the tracking representationalist respond to my argument? She could argue that synesthetic experience does not represent the same content as normal perceptual experience. In other words, she could argue that premise 2 is false: although informational semantics is true, it is not the case that Jane and Fred's experiences represent the same content. Call this the *Different Content Objection*. There are two main versions of this objection that I will consider, what I'll call the *Different Modality Objection* and the *Misrepresentation Objection*. I will start with the Different Modality Objection in this section and discuss the Misrepresentation Objection in the next section.

Given that synesthesia involves cross-modal sensations, the tracking representationalist's response to my argument might be similar to the cross-modal case of seeing and touching the same bottle discussed in the second section. Although we often simultaneously represent the same object through different modalities, e.g., seeing and touching the water bottle, each modality seems to represent a property that the other modality doesn't. For instance, touch represents temperature; vision represents color. Thus, even though our visual and tactile experiences of the bottle differ phenomenally while both represent the bottle, each modality represents a property that the other does not, hence a difference in content between the visual and tactile experiences of the bottle.

The problem for the tracking representationalist is that she cannot make a similar appeal in Jane and Fred's case because, on the face of it, both of their experiences causally co-vary with the same distal stimulus, namely Middle C (vibrations of 261.6 Hz). There isn't an extra distal stimulus that causes Jane's sensation of color like there is in the cross-modal case of seeing and

touching the same object. If Jane and Fred are receiving the same input, where is the difference in content between their experiences?

The difference in content could be in the head, so to speak. That is, the tracking representationalist might say that in the act of perceiving, the perceptual system represents a part of itself as content (Dretske 2003). For example, in viewing a bottle on a desk, the visual experience represents that the bottle is on the desk *and* that the experience is visual as well. According to this position, Fred's experience represents Middle C *and* the auditory modality. Since part of Jane's visual system is activated in representing Middle C, Jane's experience represents not only Middle C and the auditory modality, but the visual modality as well; hence the difference in representational content between Jane and Fred's experiences.

Nevertheless, we can imagine another sound-color synesthete, Steve, who experiences redness with Middle C.[15] Is the content of Steve's experience the same as Jane's since they both represent Middle C and the auditory and visual modalities? If so, then yet again, the tracking representationalist runs into the same problem: she cannot distinguish between the representational contents of Jane and Steve's perceptual experiences even though Jane experiences blueness with Middle C while Steve experiences redness.

In order to distinguish between Jane and Steve's experiences, representational content must be more specific than just the activation of a particular modality. Perhaps the content includes not only activation of the modality, but also specific patterns of neuronal activation. If the tracking representationalist factors specific patterns of neuronal activation into representational content, then she must say that the content of *perceptual experience in general* includes neural activation patterns, lest she be ad hoc and claim that it's only the neural

[15] Synesthesia is highly idiosyncratic. For example, two sound-color synesthetes will often experience different colors with the same sounds.

activation patterns of Jane and Steve's experiences that are a part of representational content. Moreover, the claim that the content of perceptual experience in general includes neural activation patterns raises a significant problem concerning the accessibility of representational content, to which I now turn.

Typically representational content is something to which the representer can attend. For instance, when I see my dog in the backyard, I can focus on specific features of my dog, like the black spots on his coat or his fluffy tail. Currently I might not be focusing on his black spots or his fluffy tale. Perhaps I'm paying attention to the hole that he's digging or to something else entirely. But, importantly, I can switch my attention to focus on his coat—it's something to which I *can* attend, and so it *can* factor into the content. However, if content includes neuronal activation patterns, then there is a part of the representational content of my experience that I don't have access to. I do not have privileged access to my brain's activation patterns. I cannot focus on the activation of area V4 in my occipital lobe when I look at and process the color of my dog's coat. Indeed, if humans had this incredible ability, then neuroimaging devices would be unnecessary, and neuroscience would be a much easier endeavor.

Therefore, by holding that the representational content of perceptual experience includes a set of activated neurons, the tracking representationalist is committed to the view that there is some aspect of representational content that is always inaccessible from the first-person perspective. This position is very problematic for the tracking representationalist given one of her central claims that phenomenal character *is* representational content. If representational content is inaccessible, and phenomenal character is representational content, then the tracking representationalist holds the undesirable position that phenomenal character is inaccessible. But that's absurd. Phenomenal character is an immediately apparent aspect of experience—plausibly

the most striking component of experience. Thus, if the tracking representationalist holds that neuronal activation patterns are a part of representational content, then she also holds the incoherent view that the way an experience feels from a first-person perspective is inaccessible from a first-person perspective, but rather must be known about via sophisticated empirical tools, which directly violates the transparency thesis that is a large motivation for the strong representationalist view.

If the tracking representationalist says that a difference in content arises because different modalities are activated and are represented in the content, then there is no way to distinguish between synesthetes with the same inducer-concurrent pairings who still experience different sensations (one experiences blueness with Middle C, the other redness). The content, then, needs to be more specific than the activation of modalities, like different neuronal activation patterns. However, if neuronal activation patterns are part of representational content, then part of the content of experience is always inaccessible from the first-person perspective. Any appeal to content that is more specific than activated modalities will likely run into the problem of being inaccessible from the first-person perspective.

8 MISREPRESENTATION

There is another version of the Different Content Objection, namely the Misrepresentation Objection. Although Jane and Fred receive the same input, a difference in the representational contents of their experiences need not arise from within the perceivers. Rather, the tracking representationalist can point to a difference in content between synesthetic and normal experiences that becomes apparent when we consider the notion of misrepresentation. This objection posits that part of what it means for a representation to be tokened in normal conditions is for the perceptual system to be functioning properly, or according to its biological function.

The structure of this section is as follows. First, I will make some preliminary remarks in order to appropriately set up the objection. I discuss how the notion of misrepresentation has historically been a problem for informational semantics. In 8.1, I argue that a causal theory of content that incorporates some notion of teleology and function would have a better set of theoretical tools to say that synesthesia is a misrepresentation. However, in 8.2, I draw a skeptical conclusion that invoking teleology and function will solve the problem. The teleofunctionalist will appeal to the fact synesthesia is not an adaptation, and so synesthetes and normal perceivers cannot represent the same content. I entertain whether it is likely that synesthesia will ever be an adaptation. I claim that is it not very likely. However, it is definitely conceivable that synesthesia is an adaptation. That is, we can imagine a world like ours where synesthesia has a biological function. I conclude section 8 by explaining why this is a problem for the tracking representationalist who adopts teleofunctionalism in favor of informational semantics.

In order for this objection to work, Jane's synesthetic experience must be divided into different parts: the sound representation and the color representation. In section 5, I posited that

the kind of perceptual experience had by the sound-color synesthete is partly an amalgam of color and sound sensations. This sui generis sensation is something like normal perceivers' experiences of color and sound combined into something more complex. If synesthetic experience involves a sui generis representation, one that is not just a sum of its parts, then this objection does not work. If she wants to say that synesthetic representations are inaccurate, and she agrees with me that they are sui generis and cannot be appropriately divided into separate sound and color representations, then she must say that Jane doesn't accurately represent sound properties. But this is an odd position. If sound-color synesthetes misrepresent anything, it surely isn't sound. As noted in Section 5, sound-color synesthesia and absolute pitch often co-occur (20% of those with absolute pitch are sound-color synesthetes, well above the estimated average of synesthesia occurring in the population). Relatedly, as discussed in Section 3, synesthesia is highly consistent. So, if anything, sound-color synesthetes are *better* than normal perceivers at detecting sound properties. In which case, it makes more sense to hold that if sound-color synesthetes misrepresent, then they misrepresent color—their perceptual apparatus tells them that a color is present when really there is no color property instantiated.

However, if Jane's experience can be appropriately analyzed in terms of separate color and sound representations, then the tracking representationalist can argue that each part represents something different. The sound representation represents a sound property because in normal conditions, sound representations causally co-vary with sound properties. In a similar vein, the color representation that is tokened in response to Middle C represents a color property because in normal conditions, color representations causally co-vary with color properties. Jane's synesthetic experience as a whole represents both sound and color. Here is where the tracking

representationalist gets a difference in content between Jane and Fred's experiences: Fred's experience doesn't represent color, whereas Jane's does.

One virtue of capturing synesthesia this way is that it nicely aligns with an intuitive understanding of synesthetic experience. On the face of it, synesthetic experience does not seem veridical—what it says about the world seems to be false. By claiming that the concurrent part of the synesthetic representation is inaccurate, the tracking representationalist captures this intuitive reading of synesthesia as a kind of hallucination.[16] In Jane's case, the sound representation is accurate because it causally co-varies with sound in normal conditions. However, the color representation of Jane's synesthetic experience is inaccurate, i.e., a misrepresentation, because in normal conditions, color representations causally co-vary with color properties, not sound properties.

In order to make this objection go through, the tracking representationalist needs to say which informational semantics condition is not met. There are three conditions listed in Section 4 that a representation must meet in order to be contentful, namely the *causal condition,* the *co-variation condition,* and the *normal conditions condition*. The last condition pertaining to normal conditions is most likely where the tracking representationalist will push back by claiming that Jane's color experience is a misrepresentation because it's not tokened in normal conditions.

One thing to note is that informational semantics has a notoriously difficult time accounting for misrepresentation.[17] If a causal relation to something external constitutes representational content, then how can a representation be inaccurate? Imagine that a cow looks to me to be a horse, and I mistakenly think to myself, "That's a horse." The property of being a

[16] In fact, one might think that if a theory cannot account for synesthesia as a kind of non-veridical experience, then perhaps that's a good reason to dismiss the theory.
[17] See Rupert (2008) and Godfrey-Smith (1987) for clear articulations of the problems associated with informational semantics.

cow has caused my token of HORSE. If both horses and cows causally co-vary with HORSE representations, then HORSE represents horses or cows. So, according to the basics of informational semantics, thinking "That's a horse" when I see a cow is not mistaken. But it is mistaken! It seems, then, that there is no room for fallible representation in the informational program.

This is a serious problem for anyone who adopts informational semantics, including tracking representationalists. How can the tracking representationalist say that Jane's synesthetic representation is inaccurate? Since synesthesia is not ubiquitous, perhaps she can point to the fact that synesthesia is not statistically normal. Often times, things that are statistically normal are functioning properly, and so perhaps Jane's system is malfunctioning because it is abnormal. This line of thought is weak for three key reasons. First, whether a system is "normal" depends on a reference class. Normality for a synesthete could refer to other similar synesthetes rather than non-synesthetes. Second, there can be an extremely rare system (say, the only one of its kind) that functions perfectly reliably. Third, a difference in perceptual and representational capacities between two systems doesn't entail that one of the systems is therefore malfunctioning.

8.1 Invoking teleology and function

At this point, in order to hold that synesthetic representations are inaccurate, and so preserve the Misrepresentation Objection, a plausible route for the tracking representationalist is to embed some notion of biological function or teleology into the notion of normal conditions. In fact, when faced with the problem of misrepresentation, many informational semanticists turned to biological function or teleology. As Godfrey-Smith (1987, p. 541) remarks, "The temptation to wax teleological at this point is strong, and many succumb." By doing so, a constraint is placed on what counts as the cause of a representation in 'normal conditions' or in cases of

perceptual proper functioning. One thing to note, however, is that once the tracking representationalist invokes biological function, she no longer holds onto a purely informational theory of content. Rather, she adopts a teleofunctional theory of content.

Although adopting a teleofunctional theory of content is a plausible route, there is some ambiguity in exactly how to incorporate teleology and function. Instead of discussing the myriad ways one might do this, I will discuss a basic version of teleofunctionalism that holds that part of what it means for a representation to be tokened in normal conditions is that the organism's perceptual system has the right kind of evolutionary history, namely that it is performing its biological function.[18] The biological function of a system is an adaptation, whatever the system was evolutionarily selected to do—the function increased the chances its bearer would survive and reproduce in the environment of evolutionary adaptation. According to this line of thought, perhaps Jane's visual system is not performing its biological function, namely to accurately detect color properties. If her visual system is not performing this function, then it is malfunctioning and the representation is not tokened in normal conditions. Thus, in order to claim that Jane's visual system is operating under normal conditions and so Jane's color representation is inaccurate, the tracking representationalist will point to the fact that synesthesia is not an adaptation, that is, it was not directly selected for.

Perhaps one doesn't find it intuitive that synesthetic systems are malfunctioning. After all, the cross-modal experiences are highly consistent. The same inducer-concurrent pairings remain stable throughout a synesthete's life. Moreover, we can imagine mechanisms that are not adaptations but still, on the face of it, seem to function reliably. For example, think of a child who, due to a rare genetic mutation, is born with a heart that has five (instead of four) chambers.

[18] Both Tye (1995) and Dretske (1995) invoke biological function in their tracking theories of intentionality.

Suppose that this extra chamber in no way impedes the heart's ability to pump blood to various parts of her body. In other words, the extra chamber does not interfere with the heart's execution of its main function (the reason why it was selected in the first place), namely to effectively pump blood. Suppose further that this extra chamber not only doesn't hinder the heart's main function to pump blood, but it enhances it. That is, this five-chamber heart pumps blood more effectively than four-chambered hearts. It seems strange to insist that the five-chamber heart is *malfunctioning* simply because it does not share the same evolutionary history, i.e., was not directly selected for, as the four-chamber heart. The mutated heart solves the same evolutionary problem as the normal heart; it even does so better!

Take, for another example, postaxial polydactly, which is a supernumerary toe on the side of each foot. Suppose these extra toes in no way impair their bearers from walking and running normally. Further suppose that they actually enhance the bearer's balance. The extra toes, although abnormal and not directly selected for, perform the same function as the other toes, namely to help one balance.

These examples are, prima facie, cases of reliable functioning. Although they might tempt one to hold that a system can reliably represent without the right kind of evolutionary history, the teleofunctionalist will simply deny this intuition. If one finds these examples intuitively pulling, then one might outright reject that biological function should be included in what it means to be a normal condition. But what if we assume that the teleofunctionalist has it right? Can the tracking representationalist who adopts teleofunctionalism as opposed to a bare causal co-variational account of mental content make sense of synesthesia? I'm skeptical that she can. In the next subsection, I detail why.

8.2 Synesthesia and adaptation

The teleofunctionalist is right that, clearly, synesthesia is not an adaptation—the human visual system was not evolutionarily selected to produce color sensations in response to auditory stimuli; the tactile system was not evolutionarily selected to produce tactile sensations in response to gustatory stimuli; and so on. However, although it's indisputable that synesthesia is currently not an adaptation, some argue that synesthetes are like "real-world X-men," the next step in human evolution given their abilities to detect patterns and process information better than non-synesthetes. Given their superior, mutant-like abilities, and synesthesia's hereditability, some argue that while synesthesia is not directly selected for now, it is plausible that it will be selected for sometime in the future. If synesthesia does become an adaptation in the future, then the teleofunctionalist is in a weird position. She has to say that synesthetes are misrepresenting now, but in the future, they won't be misrepresenting—even though nothing has changed about the mechanistic structure of the synesthetic system.

Nonetheless, the teleofunctionalist will point out that the claim that synesthesia will be an adaptation is highly contentious. The environment of evolutionary adaptation would have to be very specific to one kind of synesthesia such that the abilities that kind of synesthesia affords its bearer would increase the bearer's chances of surviving and reproducing. What would an environment have to be like in order for synesthesia to be selected? Perhaps in the future, our surroundings will be covered with text (like Times Square on steroids) such that a grapheme-color synesthete's heightened ability to detect patterns and process textual information faster than non-synesthetes allows the grapheme-color synesthete to navigate this kind of environment more efficiently than a non-synesthete. Still, it's hard to see exactly how this advantage will increase the grapheme-color synesthete's chances of survival or reproduction. It's implausible

that in this future environment, processing text slightly faster will help the synesthete better evade predators, or that members of the opposite sex will find these abilities particularly sexy.

Thus, it's unlikely that synesthesia will ever become an adaptation, (although it is worth thinking about whether humans will artificially select certain kinds of synesthesia in the future.) However, Wager (1999) points out that we can still conceive of a possible world where synesthesia is an adaptation.[19] Imagine a world physically and biologically similar to ours, where auditory information is, for one reason or another, suddenly more significant for survival. Perhaps there is a new extra-terrestrial predator that is only audibly detectable. Those with sound-color synesthesia might have a better chance of evading this stealthy alien predator insofar as they might be able to detect sounds better than non-synesthetes, (or at least would generally pay more attention to the sounds). Then, the sound-color synesthetes would go on to reproduce with other sound-color synesthetes. Eventually, experiencing color with sound would become an adaption.

Granted, this thought experiment is leaving many evolutionary factors out, and it's highly contrived. Nonetheless, it's hard to deny that there are many conceivable scenarios in which some form of synesthesia could be selected for. If we can conceive of synesthesia as an adaptation, then there is some possible world where a synesthete accurately represents Middle C according to a basic version of teleofunctionalism. If there is some possible world where a synesthete represents Middle C, then we've come full circle, back to the original problem that I posed for the tracking representationalist. If it's possible to have a synesthete and normal perceiver represent the same content, Middle C, then the representationalist thesis is false. Remember, the representationalist thesis holds that, necessarily, phenomenal character and

[19] See pages 272-273.

representational content are the same thing. Put differently, a difference in phenomenal character necessarily denotes a difference in representational content.

To rehash the dialectic, I've argued that synesthetes and normal perceivers can represent the same content but experience different phenomenal characters. This is a problem for tracking representationalists insofar as representationalism holds that representational content and phenomenal character are one and the same. However, if the tracking representationalist drops plain informational semantics and adopts teleofunctionalism—a modified version of informational semantics—she can side step my argument. Teleofunctionalism modifies informational semantics in that it adds in a condition to what it means for a representation to be tokened in normal conditions, namely that the perceptual system must be executing its biological function. Synesthetic perceptual systems are not executing their biological functions because they aren't adaptations nor is it likely that they ever will be, at least not in the foreseeable future. However, we can imagine a scenario, however unlikely, in which synesthesia is directly selected for. That is, we can imagine some possible synesthete that accurately represents Middle C according to teleofunctionalism. Thus, the tracking representationalist who assumes teleofunctionalism doesn't have a way to point to a genuine difference in content between possible Jane and actual Fred's representations.

9 CONCLUSION

Synesthesia has many interesting philosophical implications. I've discussed one, namely that it poses a problem for tracking representationalism. Synesthesia offers an example of how two experiences may have different phenomenal characters yet share the same content. According to informational semantics, a sound-color synesthete and a normal perceiver represent the same content, yet the synesthete experiences a color sensation and the normal perceiver does not. However, strong representationalism claims that if two experiences have different phenomenal characters, then they must also have different representational contents. Given this tension between informational semantics and representationalism, both cannot be true. Therefore, representationalists are limited as to the kind of theory of content they can assume, and informational semanticists are limited as to the kind of theory of phenomenal experience they can assume.

In section 8, I proposed that the tracking representationalist might adopt a different theory of content, namely teleofunctionalism, which invokes biological function to play a role in fixing representational content. I concluded that since we can imagine a world where synesthesia is an adaptation, we can imagine that this possible world synesthete and an actual normal perceiver represent the same content yet experience different phenomenal characters, which is a version of the original problem that I posed for the tracking representationalist. Thus, neither informational semantics nor teleofunctionalism seem to be compatible with tracking representationalism.

The tracking representationalist's aim to reduce consciousness or phenomenology to representation, and representation to physical properties, is an ambitious one. Although my argument poses a problem for this project, my argument doesn't definitively show that tracking representationalism is false. There are other externalist theories of content that I have not considered. For instance, I have not discussed Fodor's Asymmetric Dependence Theory, a

popular alternative to Dretske's causal co-variational account. Moreover, I only discussed a very basic version of teleofunctionalism; more nuanced versions may better address my argument. These alternate externalist theories of content may be compatible with representationalism, in which case the tracking representationalist's aim for a reductive physicalist theory is still feasible.

REFERENCES

Adams, F. & Aizawa, K. (2010). Causal Theories of Mental Content. *The Stanford Encyclopedia of Philosophy,* Edward N. Zalta (ed.), <http://plato.stanford.edu/archives/spr2010/entries/content-causal/>.

Aleman, A., Rutten, G. J., Sitskoorn, M., Dauzenberg, G., & Ramsey, N. F. (2001). Activation of Striate Cortex in Absence of Visual Stimulation: An fMRI Study of Synesthesia. *Neuroreport, 12*, 2827-2830.

Baron-Cohen, S., Harrison, J., Goldstein, L.H., & Wyke, M. (1993). Coloured speech perception: Is synaesthesia what happens when modularity breaks down?, *Perception*, *22,* (4): 419–26.

Baron-Cohen, S., Wyke, M., & Binnie, C. (1987). Hearing words and seeing colours: an experimental investigation of a case of synaesthesia. *Perception 16*:761 767.

Block, N. (1990). Inverted Earth, *Philosophical Perspectives*, *4*, 53-79.

------- (2006). Bodily Sensations as an Obstacle for Representationism. *Pain: New Essays on Its Nature and the Methodology of Its Study*. M. Aydede, Ed. Cambridge, MA: MIT Press.

Brang, D., Hubbard, E. M., Coulson, S., Huang, M., & Ramachandran, V. S. (2010). Magnetoencephalography reveals early activation of V4 in grapheme-color synesthesia. *Neuroimage*, *53*(1), 268-274.

Brogaard, B., Vanni S., and Silvanto, J. (2013). Seeing mathematics: Perceptual experience and brain actibity in acquired synesthesia. *Neurocase, 19*(6): 566-575.

Cohen Kadosh, R., Cohen Kadosh, K., and Henik, A. (2007). The neuronal correlate of bidirectional synesthesia: a combined event-related potential and functional magnetic resonance imaging study. *Journal Of Cognitive*

Neuroscience, 19 (12): 2050-2059.

Cutter, B., and M. Tye. (2011). Tracking representationalism and the painfulness of pain. *Philosophical Issues, 21*(1): 90-109.

Cytowic, R. E. (1997). Synaesthesia: phenomenology and neuropsychology. In S. Baron Cohen & J.E. Harrison (eds). *Synaesthesia: classic and contemporary readings* (17-42). Oxford: Basil Blackwell.

------- (2002). Synesthesia: A Union of the Senses. Cambridge, MA: MIT Press.

Dixon, M. J., Smilek, D., & Merikle, P. M. (2004). Not all synaesthetes are created equal: Projector versus associator synaesthetes. *Cognitive, Affective, & Behavioral Neuroscience, 4*, 335–343.

Dretske, F. (1981). *Knowledge and the Flow of Information.* Cambridge, MA: MIT Press.

------- (1988). *Explaining Behavior*.

------- (1995). *Naturalizing the Mind.* Cambridge, MA: MIT Press.

------- (2003). Experience as Representation. *Philosophical Issues, 13* (1): 67-82.

Fodor, J. (1987). *Psychosemantics: The Problem of Meaning in the Philosophy of Mind.* Cambridge, MA: MIT Press.

-------(1990). *A Theory of Content and Other Essays.* Cambridge, MA: MIT Press.

Goller, A. J. (2009). Seeing Sounds and Hearing Colors: An Event-related Potential Study of Auditory-Visual Synesthesia. *Journal Of Cognitive Neuroscience*, *21*(10), 1869-1881.

Godfrey-Smith, Peter. (1987). Misinformation. *Canadian Journal of Philosophy, 19*(4), 533-550.

Gregersen, P., Kowalsky, E., Lee, A., Baron-Cohen, S., Fisher, S., Asher, J., & Li, W. (2013). Absolute pitch exhibits phenotypic and genetic overlap with synesthesia. *Human*

Molecular Genetics, *22*(10), 2097-2104.

Grossenbacher, P.G. & Lovelace, C.T. (2001). Mechanisms of synesthesia: cognitive and physiological constraints. *Trends in Cognitive Sciences, 5*(1), 36-41.

Hubbard, E. M., Arman, A. C., Ramachandran, V. S., & Boynton, G. M. (2005). Individual Differences among Grapheme-Color Synesthetes: Brain Behavior Correlations. *Neuron*, *45*975-985.

Lycan, W. (1996). Layered perceptual representation. Philosophical Issues 7 :81- 100.

Novich, S., Cheng, S., & Eagleman, D. M. (2011). Is synaesthesia one condition or many? A large-scale analysis reveals subgroups. *Journal Of Neuropsychology*, *5*(2), 353-371.

Nunn, J. A., Gregory, L. J., Brammer, M., Williams, S. C., Parslow, D. M., Morgan, M. J. (2002). Functional magnetic resonance imaging of synesthesia: Activation of V4/V8 by spoken words. *Nature Neuroscience, 5*, 71-375.

Peacocke, C. (1983). *Sense and Content*. Oxford: Oxford University Press.

Ramachandran, V. S., & Hubbard, E. M. (2001). Synaesethsia: A window into perception, thought, and language. *Journal of Consciousness Studies, 8,* 3-34.

Rupert, R. (2008). Causal theories of mental content. *Philosophy Compass, 3,* 353 380.

Sperling, J. M., Prvulovic, D., Linden, D. J., Singer, W., & Stirn, A. (2006). Neuronal correlates of colour-graphemic synaesthesia: A fMRI study. *Cortex: 42*(2), 295-303.

Steven, M. S., Hansen, P., Blakemore, C. (2006). Physiology/Imaging: Activation of color-selective areas of the visual cortex in a blind synesthete. *Cortex, 42*, 304 308.

Tye, M. (1995). *Ten Problems of Consciousness*: A Representational Theory of the

Phenomenal Mind. MIT Press.

-------- (2000). *Consciousness, Color, and Content*. MIT Press.

-------- (2002). Representationalism and the Transparency of Experience. *Nous*

-------- (2003). Blurry images, double vision, and other oddities: New problems for representationalism? In Q. Smith and A. Jokic (eds.) *Consciousness: New Philosophical Perspectives*. Oxford University Press.

Wager, A. (1999). Extra Qualia Problem: Synaesthesia and Representationalism. *Philosophical Psychology*, *12(3)*, 263-281.