# Seeing Minds, Matter, and Meaning:
# The CEEing Model of Pre-Reflective Subjective Construal

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Although subjective construal (i.e., our personal understanding of situations and the people and objects within them) has been an enduring topic in social psychology, its underlying mechanisms have never been fully explored. This review presents subjective construals as a kind of seeing (i.e., pre-reflective processes associated with effortless meaning-making). Three distinct forms of "seeing" (visual, semantic, and psychological) are discussed to highlight the breadth of these construals. The *CEEing model* characterizes these distinct domains of pre-reflective construals as all being *C*oherent *E*ffortless *E*xperiences associated with lateral posterior parietal cortex, lateral posterior temporal cortex, tempororoparietal junction, and ventral temporal cortex in an area dubbed *gestalt cortex*. The link between subjective construals and gestalt cortex is further strengthened by evidence showing that when people have similar subjective construals (i.e., they see things similarly) they show greater neural synchrony (i.e., correlated neural fluctuations over time) with each other in gestalt cortex. The fact that the act of CEEing tends to inhibit alternative construals is discussed as one of the multiple reasons why we fail to appreciate the idiosyncratic nature of our pre-reflective construals, leading to naïve realism and other conflict-inducing outcomes.

*Keywords:* subjective construal, coherence, naïve realism, neural synchrony, lenses

What if there were a pill you could swallow that would guarantee you would live as long as you like in a healthy body? What if the only hitch was that this pill would leave a single psychological faculty disabled—the ability to effortlessly and immediately make sense of the world around you by integrating different elements into coherent meaningful wholes. Sensory and motor systems would operate as they always have. Your language, memory, and logic would be fully intact. But effortless meaning-making would be gone forever. You might still recognize eyes, noses, and mouths, but they would no longer effortlessly come together for you as a face and an immediate indicator of whom you are looking at. When you see a smile emerge on that face, you would not immediately see a happy person in front of you, but would rather need to stop and think about how that facial expression relates to an individual's psychological state in order to logically reach that conclusion. And as this person told you a story from their lives, you might understand the individual words, but the sentences would not spontaneously gel together to give you a sense of a story's overall narrative arc.

Would you take the pill that left you with this deficit in order to achieve immortality? Such a life seems as incomprehensible to us as the world would be to any individual who went ahead with this arrangement. Our capacity to immediately experience a coherent world is the unheralded backbone of a meaningful life. The world around us is almost always immediately sensible in a way that feels effortless, is rarely considered, but yet informs nearly all of our thoughts, feelings, and behaviors. If we know how a person is seeing the world, their subsequent reactions are much more predictable.

The goal of this review is (a) to examine the experience of effortless comprehension of the world that occupies the liminal space between pure non-conscious information processing and reflective conscious thought, (b) to highlight common processes involved in very distinct forms of effortless comprehension (i.e., visual, semantic, and psychological), and (c) to examine why this type of effortless comprehension produces *naïve realism* (i.e., the sense that how one sees the world is an objective reflection of reality and that other perspectives are irrational) as a natural byproduct of its inherent characteristics. In other words, why do the same underlying mechanisms that cause the world to seem immediately sensible to us also ensure that when others see the world differently, their way of seeing will often seem impossibly nonsensical?

This review will suggest that effortless meaning-making processes are best understood as a kind of seeing (i.e., pre-reflective subjective construal). Helmholtz (1867) famously pointed out that we ought to think of perception as an inferential process. The current

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article suggests the opposite is sometimes true as well; there are also cases when it makes more sense to think of inference as akin to a perceptual process, rather than a deliberative one. Like visual seeing, other types of inferential processes (i.e., semantic and psychological) are also often inherently coherent, effortless, and conscious and thus feel more like seeing than thinking.

This paper will start with an overview of subjective construal and then present the *CEEing model* of pre-reflective subjective construal that focuses on a lateral posterior region of the brain that will be referred to as *gestalt cortex*. Gestalt cortex is hypothesized to be central to effortless meaning-making across its different forms and each of the forms of effortless meaning-making described in the opening example can be impaired by damage to gestalt cortex (Apperly et al., 2004; Chechlacz et al., 2012; Rose et al., 2011; Zhang et al., 2015). Finally, the review will consider why the structure of pre-reflective subjective construals promotes naïve realism and the implications of this model for other related phenomena. Table 1 lists all the formal propositions of the CEEing model that will be evaluated in this review.

## Subjective Construal

Carl Stumpf is a philosopher of little renown, but he is the academic grandfather to three highly influential movements that all prioritize our subjective experience and effortless comprehension of the world. One of his students, Edmund Husserl, founded the field of Phenomenology whose motto was "to the things themselves" ("Zu den Sachen selbst!") which exhorted philosophers to avoid analytical approaches that distorted the world and to return to the "lived world" (*umwelt*) as it is experienced.

Another set of Stumpf's students, Koffka, Kohler, and Wertheimer, founded the school of Gestalt psychology. Its well-known slogan, "the whole is greater than the sum of the parts"[1] refers to how humans experience stimulus arrays in terms of relationships represented in our minds rather than in the stimulus arrays themselves. Consider the pair of dots in Figure 1a (Gurwitsch, 1964).

**Table 1**
*Propositions of the CEEing Model*

| Topic |
| --- |
| *Proposition 1*—Pre-reflective subjective construals are coherent, effortless, and experiential (i.e., CEEing) processes associated with gestalt cortex |
|     *Proposition 1.1*—Gestalt cortex is associated with conscious experience |
|     *Proposition 1.2*—Gestalt cortex is not associated with conscious thought |
|     *Proposition 1.3*—Non-conscious processes that do not influence conscious experience occur outside gestalt cortex |
|     *Proposition 1.4*—Gestalt cortex is associated with effortless, rather than effortful processes |
|     *Proposition 1.5*—Coherence via integration across multiple psychological elements occurs in gestalt cortex and with conscious experience |
| *Proposition 2*—CEEing in different domains (visual, semantic, and psychological) are each associated with gestalt cortex |
| *Proposition 3*—CEEing yields idiosyncratic subjective construals as a result of the integration of sensory and non-sensory inputs to gestalt cortex |
|     *Proposition 3.1*—CEEing is influenced by non-sensory inputs to the extent that sensory inputs are ambiguous, absent, or incomplete |
|     *Proposition 3.2*—Similarity in CEEing across people is associated with greater neural synchrony between them in gestalt cortex |
| *Proposition 4*—CEEing leads to inhibition of alternative construals (or their underlying elements) |

*Note.* CEE = Coherent Effortless Experience.

**Figure 1**
*Gestalt Processes*
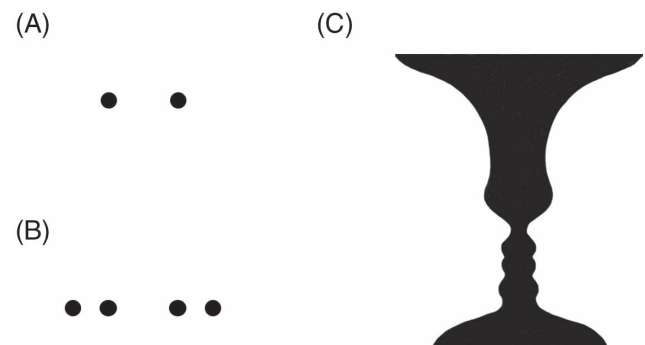


*Note.* Panel (a) shows a "pair" of dots however when those same dots are flanked by two additional dots in (b) the original "pair" is no longer psychologically present. (c) Rubin's face-vase illusion

Although there are just two individual dots, we naturally see them as a unit, as a pair. But when the same two dots are presented, unchanged, in Figure 1b, we no longer see them as having anything to do with each other as they each partake of new pairings. This "action at a distance" comes from the human mind, rather than the stimuli. Jerome Bruner, Stumpf's academic great grandson, set the cognitive revolution in motion with a similar motto focused on the fact that people are perpetually "going beyond the information given" (Bruner, 1957) to make sense of the world.

Finally, Stumpf's student Kurt Lewin and Stumpf's academic grandsons, Solomon Asch and Gordon Allport, could make a strong case for collectively being the founders of modern social psychology. For both Lewin (1943) and Asch (1948), the world as experienced by the individual was a centerpiece of their work. Behaviorism and social psychology each place a premium on the power of the situation to shape human behavior. Behaviorists believed that as long as one could completely control the situations an individual was exposed to, the person could be made into any type of individual because it is the history of situations one is exposed to that determines who they are and what they do. Social psychologists like Asch instead argued that the behaviorist approach was doomed to fail because it did not account for the individual's subjective experience of the situation—how an individual understood its meaning (Ross & Nisbett, 1991). For instance, Lorge and Curtiss (1936) showed that the reaction to a statement like "A little rebellion now and then is a good thing" depends largely on whether the perceiver believes the statement was authored by Thomas Jefferson or Vladimir Lenin. Asch (1948), demonstrated that while the sentence is objectively the same in both cases, the reader's understanding of the sentence is different in each case and consequently so is the reaction to it.

Modern social psychology refers to this process of making sense of situations (and the people, objects, and events that occur within them) as *subjective construal*. "Subjective" refers to the fact that this process occurs from the idiosyncratic perspective of each person and

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[1] Some have pointed out that the correct translation is actually "the whole is different than the sum of the parts," but the implication about the irreducibility of human experience and constructive contributions of the mind to what is seen follows from either translation.

"construal" comes from the Latin root *construere* which means "to build up, pile together." Lee Ross and colleagues (Griffin & Ross, 1991; Ross & Nisbett, 1991; Ross & Ward, 1996) have written extensively about subjective construal focusing on two major aspects of this phenomenon.

First, this work describes some of the antecedent factors that influence the construals we generate such as framing effects and priming. Framing the same objective events as potential gains or losses influences how individuals construe the events and subsequently respond (Kahnemann & Tversky, 1984; Tversky & Kahneman, 1981). Similarly, priming words related to cooperation will lead individuals to understand the prisoner's dilemma as one that naturally calls out for cooperative behavior (Kay & Ross, 2003). We also know that motivational processes can dramatically affect construals (Caruso et al., 2009), but also that construals of others' actions are often relatively immune to the situational context as evidenced by the correspondence bias (Gilbert & Malone, 1995).

Second, and much more extensively, the subjective construal literature has focused on our failure to properly understand and appreciate the idiosyncratic nature of subjective construal processes and the consequences this has on several interpersonal outcomes. Naïve realism, the tendency to mistake our constructed understandings for an objective readout of reality, has a variety of pernicious effects including: A presumption that other rational and informed individuals will see things as we do and when they do not, it is because they are misinformed, lazy, unreasonable, or biased (Ross & Ward, 1996). This leads to various undesirable phenomena including the false consensus effect (Gilovich, 1990; Ross et al., 1977), the hostile media effect (Vallone et al., 1985), false polarization (Sherman et al., 2003), and the bias blindspot (Pronin et al., 2002)—all of which make it more difficult for groups in conflict to find common ground. Note that naïve realism is being used in the psychological sense here, which is related to but also distinct from the philosophical use of the same term (Searle, 2015).

Subjective construal is a powerful explanatory construct, essential to countless social psychological phenomena from social influence to attribution theory (Griffin & Ross, 1991), but most often the notion of construal is implicit in the research rather than front and center. In other words, a lot of social psychology *makes use of* subjective construals but does not focus on *what they are*, in and of themselves, and what the fundamental intrinsic consequences are of generating a subjective construal. Subjective construal is typically described in terms of interpretation and understanding, but this is relatively vague as there are many ways to interpret and understand the meaning of these terms. For instance, it is unclear whether subjective construal processes are effortful intentional processes or more effortless non-deliberative processes. On the one hand, the types of antecedent causes and consequences of construals suggest they may be more effortless. On the other hand, construals are often described in language that suggest effort and intention with phrasing such as: "active construction process," "active cognitive processes," "situational definitions are negotiated," "assigning meaning," "working to create a meaningful whole," and "the label given to . . . particular situations." Each of these phrases could potentially refer to something effortless and experiential, but without further nuance provided, they suggest more willful activity. One possibility is that there is more than one kind of construal process. The next section addresses this possibility and suggests that although there

likely is more than one type of construal, only the effortless non-deliberative variety is likely to promote naïve realism.

## Reflective and Pre-Reflective Construals

It is likely that there are at least two distinct ways to understand a situation in terms of what it is, what its significance is, and what opportunities or actions it affords us. There are reflective construals which are effortful, propositional, and typically linguistic and there are pre-reflective construals hypothesized to be low effort, non-propositional, but still conscious, processes (Block, 1995; Lieberman et al., 2002; Sartre, 1936/1957; Schooler, 2002). While these processes are conceptually dissociable, they likely work together in many contexts, each serving as inputs to the other. Nevertheless, it will be argued that only pre-reflective construal processes produce naïve realism as a byproduct of their inherent structural features.

Reflective construals generally involve intentionally trying to understand one or more things in the world or our own experience of things in the world and have an overt logical structure. If a person thinks, "My friend said I was really angry yesterday, but when I think back about it and how I felt at the time, I don't think I was angry" this is an act of reflective construal regarding one's own experience (i.e., how did I feel?). If one thinks "The acting was quite poor and the plot wasn't much better, so I would characterize it is a bad movie" one has engaged in reflective construal of the situation (i.e., what kind of movie was it?). These are propositional processes that occur in sequence rather than in parallel and likely require effort.

Pre-reflective processes constitute our immediate experience of the world (Sartre, 1936/1957) and thus do not feel like construals (i.e., something we have constructed) at all. Pre-reflective construals are dynamic from moment to moment and together reflect the experiential meaningfulness of the *stream of consciousness* (James, 1890/1950; Oliver, 1844). These experiences are what reflective construals typically take as their objects. Note that while pre-reflective construals commonly emerge from many non-conscious processes that operate in parallel, only one conscious pre-reflective construal is hypothesized to be present at a time. In other words, many non-conscious contributors to a pre-reflective construal can occur simultaneous, but the pre-reflective construals themselves occur in sequence.

Watching films and television represent one of the best examples of when pre-reflective construals might occur in relative isolation. We can watch a scene for several minutes, being carried along by a straightforward narrative without ever pausing to think about the meaning of what's going on or stopping to reflect on our own reactions to it. Although a movie critic might engage in reflective processing while watching, for the rest of us, watching television minimizes reflective processes (Moskalenko & Heine, 2003). Despite the absence of deliberation and reflection, we usually have a clear sense that everything in the scene we are watching makes sense. This pre-reflective construal produces a conscious experience infused with sensibility, but does so without apparent effort—the world seems sensible as soon as we see it in most contexts. That said, we can reflect on these pre-reflective construals using pre-reflective construals as inputs to more reflective ones. Similarly, the outputs of reflective construal processes often serve as inputs to subsequent pre-reflective construal. Thus, while the two types of construals can be isolated, in daily life they often work hand in hand with each other.

Note that the distinction between reflective and pre-reflective processing, as described thus far, roughly parallels numerous dual-process models and is in no way novel (Evans & Stanovich, 2013; Kahneman, 2011; Sherman et al., 2014). This distinction is presented here not to lay out a new dual-process account, but rather to characterize the limited scope of this review (i.e., pre-reflective construals) relative to the full range of construals. The primary contribution of this review will be the integration of a psychological account of pre-reflective construals with a neural account, which will offer a novel explanation of why subjective construals often promote naïve realism.

## Seeing, Seeing, and More Seeing

Our entry point for expanding on the definitional characteristics of pre-reflective construals begins with the multiple meanings of the word "see" (Table 2). Seeing may be the most paradigmatic way to approach pre-reflective construals in the empirical literature, but only once its various uses are considered together as part of a combined umbrella process. Here, I lay out three different uses of the word "seeing" and suggest that although the uses seem quite different, they each illustrate the same definitional characteristics of pre-reflective construal and involve processes that phenomenologically feel quite similar.

Most commonly, the word *seeing* is used to connote the conscious visual experience of physical entities in the world (e.g., seeing a mountain). To see something means we consciously understand that some particular thing exists in a particular place in the world. While there is non-conscious visual information processing, seeing always describes something conscious.

There are other phenomena that we refer to as seeing that are not, strictly speaking, visual. When a baby is lying on its stomach with its arm extended and its open hand hovering near a toy that is just beyond its grasp, we immediately "see" that the baby *wants* the toy and is *reaching* for it (Rizzolatti & Craighero, 2004). The psychological states that are "seen" (i.e., wanting and reaching) are not visible, but experientially, this feels like seeing and has many of the same characteristics. We do not see the baby first and then think about what its arm position means; it is an all-at-once experience just like when we see the physical world. In this case, another's mind has a perceptual presence for us much like other objects in the world (Noë, 2005; Smith, 2010). Similar to how a coin is seen as round despite its retinal projection being elliptical most of the time (Smith, 2000), the retinal projection from an arm extended over a toy is "seen" as wanting and reaching. In both cases, the seeing

comes first and the objective contents of the retinal projection are only likely to be noticed in their own right with reflective thought and a detached attitude (Hochstein & Ahissar, 2002).

Although one could argue that at least in some cases, *seeing minds* (or the related concept of "social vision"; Johnson & Adams, 2013) is still rooted in seeing the physical world, depending on rapid inferences from visible cues, the same cannot be said of the seeing that occurs in the context of semantics and narrative (i.e., *seeing meaning*). When another person shares their point of view on some issue, we might respond "I see what you mean," "We really see eye to eye on this" or "I see things differently than you do." In these cases, the word "see" appears to be used with an altogether different meaning than visual seeing.

If this non-visual use of "see" is a linguistic accident, it is a surprisingly common one. In most European languages, there is a single word that can be used to indicate seeing in both "I see the sunset" and "I see what you mean." A number of these instances may stem from the latin root *sequi* which means "to follow," appropriate for both uses. However, the same overlap also appears in numerous other nonromance languages (see Table 3). Among the languages examined, only East Asian languages seem to consistently lack a single word for both of these meanings. If it was merely a linguistic accident that the same word was used for these two unrelated meanings, this accident should not occur repeatedly across languages. For instance, in other languages the same word is not used for bear (i.e., the animal) and bear (i.e., the ability to withstand something).

## Augmented Reality

Seeing and thinking might intuitively seem like opposites, with the former reflecting visual reality and the latter used to generate meaning and understanding. However, successful perception is nearly always a form of efficient meaning-making. In other words, perception is built to be meaningful, rather than merely providing pixel-by-pixel visual building blocks that are only made meaningful with the addition of thought and reflection. Consider the head-up displays (HUD) in augmented reality glasses or projected onto a car windshield. HUDs do not display all possible information as it exists in the world. Rather, HUDs are designed to detect meaningful features of the environment and highlight them in an easily understood format. This is actually what basic perception is doing continuously; it is biased toward meaningful aspects of the environment rather than merely revealing reality as it is.

Take color vision as an example. Our ability to experience color seems to directly reflect color variation in the world, suggesting

**Table 2**
*Types of Seeing*

| Type | Example | Visible components | Non-visible components |
|------|---------|--------------------|------------------------|
| Visual ("seeing matter") | "I see a mountain" | Aspects of object facing individual | Aspect of object not facing individual<br>Occluded parts of objects<br>Hidden features (e.g., weight of object) |
| Psychological ("seeing minds") | "I see the baby wants the toy" | Facial cues<br>Bodily movements and actions | Minds, mental states, and traits |
| Semantic ("seeing meaning") | "I see what you mean" | Written words | Semantic meaning, narrative arc |

**Table 3**
*Words That Can Be Used in Both "I See the Sunset" and "I See What You Mean" in Different Languages*

| Language | Word |
| --- | --- |
| English | see |
| French | vois |
| German | sehe |
| Portuguese | vejo |
| Spanish | veo |
| Dutch | zie |
| Gaelic | chì mi |
| Welsh | rwy'n gweld |
| Swedish | ser |
| Greek | βλέπω |
| Armenian | տեսնել |
| Azerbaijani | görürəm |
| Swahili | ninaona |
| Samoan | vaai |
| Tagalog | nakikita |
| Javanese | ndeleng |
| Hawaiian | 'ike |
| Arabic | رى |
| Hebrew | רואה |
| Punjabi | ਵੇਖਦਾ |
| Russian | вижу |

there is nothing inherently meaningful about color. But the reality is quite different. Color does not actually exist in the world, only in our perceptual processing. Moreover, according to evolutionary biologists, color processing evolved to effortlessly highlight meaningful features of the environment. Non-primate mammals tend to be dichromatic seeing only violet, blue, green, and yellow. They are essentially red–green colorblind, incapable of differentiating reds and oranges from green. Given that the ratio of brain-to-body is disproportionately greater in primates than other mammals and the brain is the most calorically expensive organ of the body, there was an evolutionary pressure for primates to be able to discriminate between high and low energy foods (Foroni et al., 2016). Red and orange fruits and foliage tend to be more nutrient-dense and calorie-rich than green fruits and foliage and thus discriminating between these may have provided an advantage to primates who could distinguish between these colors.

Color is our subjective experience of different wavelengths of light that reflect off of objects. It augments the reality we would otherwise see in a way that was effortlessly meaningful and useful to our evolutionary ancestors. In essence, color was used to detect and tag the environment for the presence of high calorie foods.[2]

In our modern world, if we were unable to consciously experience color, we could create a HUD, a digital readout inside a set of glasses or goggles that could overlay what we see with important characteristics of the environment. It could highlight the color of different objects with letters like "r," "o," "b," "g," and "y" based on the wavelengths hitting the sensor. We could search for "r" and "o" elements to find higher calorie food options despite no experience of color. The benefits of actual color vision relative to this sort of symbol-based HUD are immediately evident in Figure 2 where the information that color conveys is technically available in the left panel (each letter corresponds to a color, with one color shaded to make it at least minimally intelligible for the reader) and as actually experienced in the right panel. The left panel could be made

meaningful through a painstaking reflective construal process, but the right panel is effortlessly and immediately meaningful.

One of the brilliant consequences of human brain evolution is that it gave us built-in HUDs that put the world in an immediate, highly integrated meaningful experiential code that does not require reflection to decode. This integrated experiential coding is not limited to things that are strictly visual or sensory in nature. We immediately experience many features of the world, but only visually see a few like color, shape, and motion. Other psychological features are experienced too, but the nature of those experiences may be harder to verbalize than visual dimensions. We experience at least some of the intentions, desires, and feelings of others without necessarily being able to point to the input dimensions that give rise to these experiences. Note that I am not suggesting our evolved visual and non-visual HUDs are perfectly accurate. Rather they are experienced as immediately meaningful and true, producing interpersonal problems in part because they can be inaccurate or different from the assessments of those around us.

## The CEEing Model

The CEEing model is a neurocognitive account of pre-reflective construals and their effects. The term CEEing (pronounced "seeing with a C") is an acronym for the core characteristics of pre-reflective construal processes: CEEing is an intentional homophone of "seeing" because the three forms of seeing (visual, semantic, and psychological) are empirically well-characterized examples of coherent effortless experience and together reflect the breadth of this umbrella term.

The CEEing model consists of four major propositions (see Table 1). The first proposition (*P1*) states that: *Pre-reflective subjective construals are coherent, effortless, and experiential (i.e., CEEing) processes associated with gestalt cortex*. This proposition is fleshed out in several corollary propositions (*P1.1–1.5*) that address each element of CEEing separately. The anatomical definition of gestalt cortex will be refined below, but it generally refers to the lateral parietal and temporal regions situated between primary visual cortex, primary auditory cortex, and somatosensory cortex. The second proposition (*P2*) states that: *CEEing in different domains (visual, semantic, and psychological) are each associated with gestalt cortex*. The third proposition (*P3*) states that: *CEEing yields idiosyncratic subjective construals as a result of the integration of sensory and non-sensory inputs to gestalt cortex*. Critically, a corollary proposition (*P3.1*) states that: *CEEing is influenced by nonsensory inputs to the extent that sensory inputs are ambiguous, absent, or incomplete*. As a result, the degree of *similarity in construals across people can be detected in gestalt cortex* (*P3.2*). The fourth proposition (*P4*) states that: *CEEing leads to inhibition of alternative construals (or their underlying elements)*. Thus, proposition 3 explains why we can be exposed to the same inputs and yet see the world differently from one another, while proposition 4 helps explain why we often cannot accept others' different ways of seeing because other potential interpretations have been inhibited. The remainder of this section defines what is meant by each of

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[2] An alternative account suggests red color vision evolved to detect emotional states of conspecifics via skin color changes (Changizi et al., 2006), but the same principle of tagging important features of the environment in an efficient manner would apply.

**Figure 2**
*Color Represented Symbolically and Visually*

(A)　　　　　　　　　　　　　　　　　　(B)
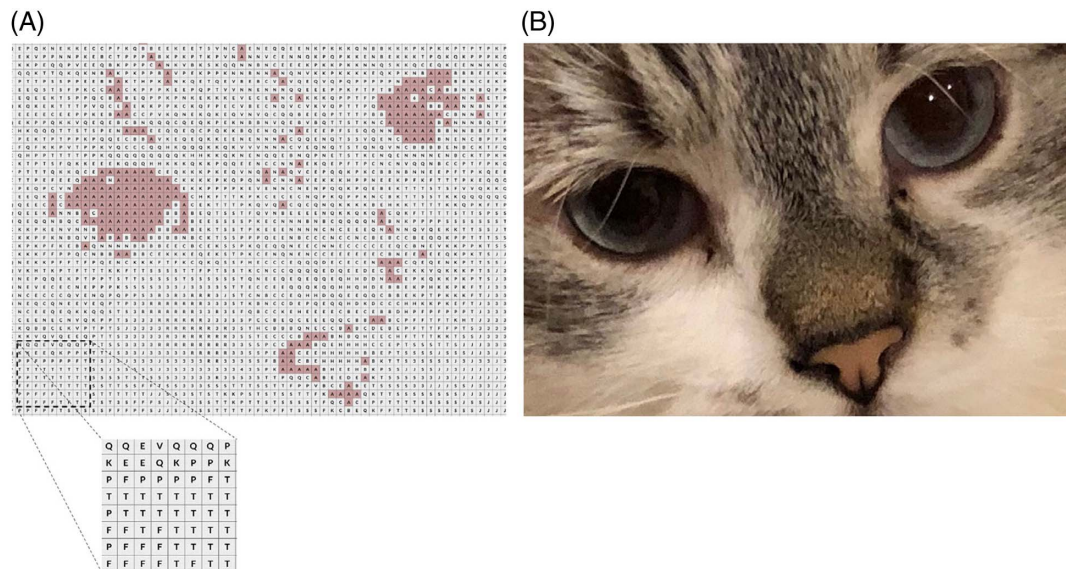


*Note.* Panel (a) Color by number picture with one color shaded in to provide some visual cues. Each square contains a letter indicating a particular hue as seen in the expanded section. (b) The original picture of our cat "Kobe". See the online article for the color version of this figure.

the characteristics of CEEing (*P1*; conscious, effortless, coherent), the inhibitory consequences of CEEing (*P4*), and the idiosyncratic nature of CEEing (*P3*). It should be noted that while some of the psychological characteristics of CEEing (e.g., effortlessness) have been constituents of dual-process models that have been studied by social and cognitive psychologists for decades (Evans & Stanovich, 2013; Kahneman, 2011; Sherman et al., 2014), other characteristics such as coherence and inhibition have never been joined together with effortlessness as part of the same "system" within these models.

### Conscious Experience

The CEEing model is fundamentally phenomenological in that each construal refers to something consciously experienced (*P1.1*). It is also important to note that although CEEing is conscious, CEEing is associated with conscious *experience*, not conscious *thought* (*P1.2*). Experiential, here, also refers to there being something that it is like to have pre-reflective construals (Nagel, 1974). There is nothing that it is like to be a tube of toothpaste and there is nothing that it is like to have a non-conscious association activated that never influences conscious processes, but there is something that it is like to watch a political advertisement and what that something is like usually differs spontaneously as a function of one's political affiliation. Although, the data that will be reviewed below is not always assessed in terms of being experiential, the goal is to emphasize the experiential aspects where possible. It should also be noted that for the remainder of this article, "experiential" and "conscious" will be used interchangeably except when referring specifically to "conscious thought," which will be spelled out.

It is also important to specify how experiential and pre-reflective conscious processes relate to non-conscious processes. Although non-conscious processes clearly influence pre-reflective conscious processes (Higgins et al., 1977; Kay & Ross, 2003), non-conscious

processes that remain purely non-conscious and do not get incorporated into an integrative process yielding coherent conscious outputs are not considered part of CEEing. In other words, non-conscious processes initiated by subliminal presentations that do not help shape a conscious construal process should occur outside of Gestalt cortex (*P1.3*).

### Effortlessness

Some physical activities require greater effort than others; running a marathon requires greater effort than walking across the street. Along with the differences in the physical metabolic resources required for these two activities, there is also a subjective sense of how much effort is being used in each case. The same sense of subjective effort applies to activities that are purely mental rather than physical. Most people would report that they experience doing long division in their heads as more effortful than watching television. Indeed, when we open our eyes, the world is nearly always experienced as being already sensible without us feeling like we need to expend any effort to make it sensible. In other words, the immediate sensibility of the world feels subjectively effortless. Thus, the CEEing model assumes that pre-reflective construals that occur in gestalt cortex feel effortless and that as effort and cognitive load increase, activity increases outside of gestalt cortex (*P1.4*).

Various scholars have debated exactly what effort is and what it refers to. It is common for effort to be associated with a cost-benefit analysis (Kurzban, 2016; Székely & Michael, 2020). Some have suggested forecasted effort typically reflects an inherently negative evaluation of an activity (Botvinick, 2007), while others have highlighted that perceptions of effort are sometimes associated with valuing an activity more (Inzlicht et al., 2018). It has been suggested that effort is a primitive feeling (Maine de Biran, 2002)

while others have suggested it is a metacognitive representation of the amount of controlled processing resources required to perform a task (Carruthers, 2020; Massin, 2017; Westbrook & Braver, 2015).

It is beyond the scope of the current article to weigh in on these issues. However, a few points are in order to clarify how the term is and is not being used here. First, this review is only concerned with the subjective experience of effort. Even if it turned out that more individual neurons are activated and more neural computations are performed while watching television than while performing long division in one's head, the latter is still more subjectively effortful than the former because that is how it is experienced. Second, this review assumes that subjective effort is a close correlate of automaticity and working memory demand (Evans & Stanovich, 2013). Thus, because studies rarely assess subjective effort directly (cf. Alter & Oppenheimer, 2009), automaticity and working memory demand can serve as proxies for low and high effort, respectively (Jansma et al., 2007).

## Coherence

By definition, construing refers to integrating multiple elements into a meaningful singular whole. Coherence here refers both to the process of integrating across multiple inputs (i.e., generating coherence) and also to the sensibility or meaningfulness of the results (i.e., experienced coherence). The CEEing model proposes that integration across multiple elements results in conscious construals, consistent with Tononi and Edelman's theory of consciousness (1998), and that gestalt cortex is associated with these conscious integrative outputs (*P1.5*).

Constraint satisfaction processes described in connectionist models illustrate how the brain can generate global coherence effortlessly from local elements (Holyoak & Simon, 1999; John, 1992; Kunda & Thagard, 1996; McClelland et al., 2014; Read, Vanman, & Miller, 1997; Simon, 2004; Thagard & Verbeurgt, 1998). Although constraint satisfaction has most often been described in connectionist approaches, coherence from constraint satisfaction can also be implemented in newer architectures such as deep learning (Detassis et al., 2020; Thagard, forthcoming) and semantic pointer (Eliasmith, 2013) approaches.

The key starting point in understanding constraint satisfaction is that the tension between different activated local representations is encoded via connection weights representing the degree to which local representations conflict with each other. These connection weights represent the brain's implicit theory of what does and does not go together in the world. For instance, when initially looking at the Rubin's face-vase illusion (Figure 1c), there may be some low-level elements representing a contour for a white object (i.e., a face) against a black background and other local elements representing the same contour as being a contour for a black object (i.e., a vase) against a white background. However, the same location in space is very unlikely to be both a contour for a white object and a contour for a black object simultaneously and thus this will be represented in the connections between these local representations. The degree of agreement or conflict between these various elements is reflected in the connection weights between these elements (i.e., the degree of facilitatory or inhibitory connection between them). To the degree that nodes connected by inhibitory, rather than facilitatory, weights are simultaneously active, overall tension in the system increases.

Constraint satisfaction processes operate by lowering the tension, not just between two local representations, but across the entire system including many simultaneous local activations in high-dimensional space (see Figure 3). It does this iteratively, by repeatedly making small adjustments to the activation levels of the local elements as a function of other elements that are active and the connection weights between them. At a macro level, all of these adjustments are guided by a tension reduction principle, analogous to gradient descent in deep learning. If the adjustments reduce system-wide tension, then the process advances. This is not as easy as it may sound. If there are a thousand local elements in a system, adjusting an element to reduce tension with another element, will often increase tension with many others.

Constraint satisfaction proceeds until no further adjustments can be made resulting in a local minimum. When the network reaches a

**Figure 3**
*Constraint Satisfaction Networks*
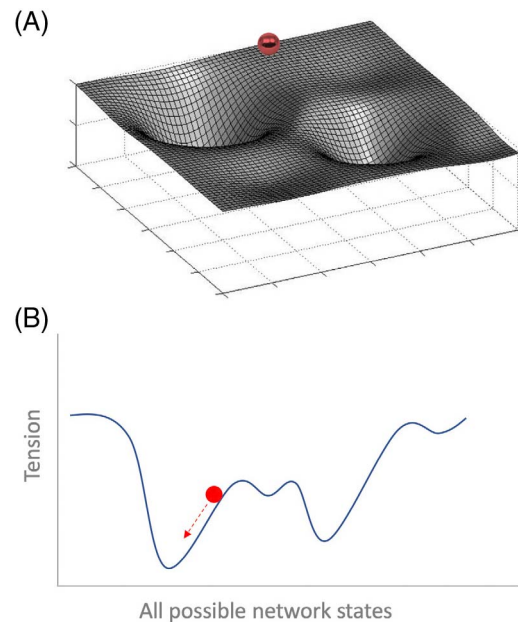


*Note.* Although constraint satisfaction networks operate in high-dimensional space with many elements possessing different levels of activation, toy examples here are given in (a) three dimensions and then (b) compressed into two dimensions. Focusing on the two-dimensional example, the x-axis represents all the different states the network can be in. The y-axis represents the total tension in the system for each given state. In each example, the red ball/circle represents the current state of the network. Constraint satisfaction is an iterative process of moving toward lower tension states by making small changes to the activation strength of the elements. The process resolves when it reaches a "local minimum" where no possible set of small changes will further reduce the tension. Note that depending on the starting point of the network, it is possible for the network to get "stuck" in a relatively high-tension local minimum, when a much lower tension local minimum exists in the continuum of possible network states. Also note that typical presentations of constraint satisfaction networks often flip the y-axis referring to local maxima rather than local minima. That is not done here because there are several conceptual advantages including intuitions about gravity applying when the y-axis is oriented this way. See the online article for the color version of this figure.

local minimum (or "attractor state") it has generated a global interpretation that is more coherent than any adjacent alternative (though it may not be the global minimum or most coherent network state possible). This means that it has found a state that is dominated by a set of mutually reinforcing units, with units representing competing alternatives inhibited to the point that they are no longer exerting any influence over the state of the network.

One of the important implications of how constraint satisfaction networks operate is that they prioritize low tension which results in increased coherence of the overall network, but they do not code for the truth value of the resulting interpretation (Simon, 2004), unlike propositional logical processes. Another important feature is the nonlinearity of constraint satisfaction processes. It is easier to fall down the slope into an attractor state than to move up the slope to exit an attractor state. Put another way, it is easier to form a subjective construal than to change a subjective construal once formed. This also implies that early information will be more influential than later information (Asch, 1946; Read et al., 1997).

Above, it was noted that non-conscious processes that do not get integrated into a conscious process are not part of CEEing and should occur outside of gestalt cortex. After discussing constraint satisfaction, this can now be expanded upon. Non-conscious processes understood through the lens of priming often seem like feedforward unidirectional processes. When primed, a stimulus like "Romeo" will spread its activation to the other concepts it is linked to such that names like "Juliet" and "Shakespeare" will become more accessible (Collins & Loftus, 1975; Neely, 1977; Schvaneveldt & Meyer, 1973). In this case, the activation of "Romeo" is the initial cause and the activation of "Juliet" is the resulting effect. In contrast, non-conscious processes understood through the lens of constraint satisfaction suggest that many representations are influencing one another's activation simultaneously, iteratively updating all of their activation levels as a function of their connection weights until they converge on a single coherent interpretation that is reflected in a consciously experienced construal. This distinction parallels the subliminal versus preconscious distinction made by Dehaene et al. (2006).

### Inhibition of Alternatives

A natural byproduct of the constraint satisfaction processes that generate coherence is that in the course of converging on a single coherent interpretation of the inputs, alternative interpretations are suppressed (P4; McClelland & Rumelhart, 1981; Usher & McClelland, 2001; Vosse & Kempen, 2000). Constraint satisfaction starts out like a democracy where every idea gets a vote, but ends up like an authoritarian regime where dissent is crushed. Recall the two local representations that were each initially active in the Rubin's face-vase example above. In reality, there are many elements initially activated based on retinal inputs that are slightly more consistent with one or the other interpretation. As one potential interpretation gains steam in the constraint satisfaction process, all of the elements associated with that interpretation are mutually reinforced and become more strongly activated. At the same time, the evidence for the competing interpretation is inhibited as those elements lose activation strength. This process functions a bit like applying contrast editing to a photo, where some details will stand out more and others are lost; it is technically a distorting process but one that can be subjectively pleasing. Note that in visual illusions

like the Rubin's face-vase, the features supporting the two interpretations are so perfectly balanced that slight changes in visual attention cause the percept to flip back and forth. In most real-world examples, like an ambiguous statement from a politician, once constraint satisfaction provides an interpretation, other interpretations are likely to stay deactivated.

### Idiosyncratic Construals

Recall that proposition 3 states that CEEing reflects the integration of sensory and non-sensory inputs that combine in gestalt cortex to yield idiosyncratic subjective construals. This claim can be unpacked further with two corollary propositions. First, the CEEing model states that CEEing will be influenced by non-sensory inputs (e.g., expectations, schemas, motivation) to the extent that sensory inputs are ambiguous, absent, or incomplete (P3.1). These non-sensory inputs are what make subjective construals subjective, as these will differ from person to person. To the extent that people have different non-sensory inputs and generate different subjective construals from the same sensory inputs, we ought to be able to track those differences in gestalt cortex. *Neural synchrony* or intersubject correlation (ISC) is a technique that assesses the extent to which neural fluctuations over time in a particular brain region correlate across two individuals as they experience something like watching a video or speaking with one another (Yeshurun et al., 2021). Thus, *construal similarity* across people should be associated with greater neural synchrony between them in gestalt cortex (P3.2).
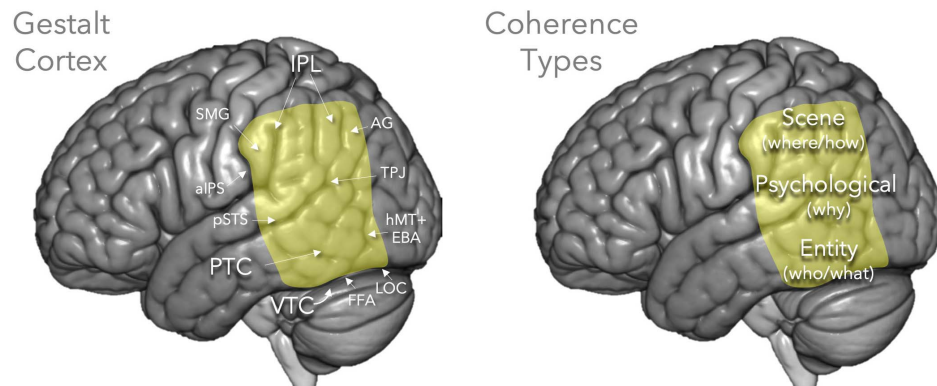
### Gestalt Cortex

Before examining the evidence that links CEEing to gestalt cortex, it is important to get more precise about the anatomical landscape of gestalt cortex. The anatomical characterization of gestalt cortex is as follows (see Figure 4, left panel). Gestalt cortex comprises all but the most dorsal portion of inferior parietal lobule (IPL), lateral posterior temporal cortex (PTC), and the ventral surface of posterior temporal cortex (VTC) excluding anterior temporal cortex. The anterior border of this region is the postcentral sulcus (non-inclusive) as well as stopping before Heschl's gyrus in the temporal lobe. The posterior border is created by drawing a boundary, from the posterior edge of the angular gyrus (AG) down to the occipital notch. On the ventral surface, this review follows Grill-Spector and Weiner's (2014) suggestion that the anterior border of VTC is defined by the anterior tip of the midfusiform gyrus and the posterior border is defined by the posterior transverse collateral sulcus (ptCoS). There are several notable subregions within gestalt cortex including temporoparietal junction (TPJ), posterior superior temporal sulcus (pSTS), anterior intraparietal sulcus (aIPS), fusiform "face" area (FFA), lateral occipital complex (LOC) which, despite its name, spans ventral and lateral aspects of occipital and temporal cortex (Grill-Spector et al., 2001), and lateral occipitotemporal cortex (LOTC) in the PTC that largely consists of the extrastriate body area (EBA) and motion-sensitive cortex (hMT+).

For those unfamiliar with neuroanatomy, this can be an overwhelming amount of foreign-sounding labels with difficult abbreviations. One heuristic for simplifying this neuroanatomy is to consider the proposed kinds of coherence generated by the dorsal (upper), middle, and ventral (lower) portions of gestalt cortex. These

**Figure 4**
*Gestalt Cortex*



*Note.* Gestalt cortex consists of inferior parietal lobule (IPL), the lateral posterior temporal cortex (PTC), and the ventral surface of posterior temporal cortex (VTC). Important subregions include: Supramarginal gyrus (SMG), angular gyrus (AG), anterior intraparietal sulcus (aIPS), temporoparietal junction (TPJ), posterior superior temporal sulcus (pSTS), motion areas for objects (hMT+) and bodies (EBA) that together comprise the lateral occipitotemporal cortex (LOTC), fusiform face area (FFA), and lateral occipital cortex (LOC). Gestalt cortex anatomy can be simplified by considering the kind of coherence produced by different areas as shown in the right panel. See the online article for the color version of this figure.

build on the well-established what-where visual pathways (Ungerleider & Mishkin, 1982). As shown in the right panel of Figure 4, ventral gestalt cortex, which includes PTC and VTC, is posited to generate *entity-level coherence*, representing people, places, and things, allowing us to CEE "who" and "what" are in front of us. Dorsal gestalt cortex, which includes IPL, is posited to generate *scene-level coherence*, representing where and how entities are interacting with one another. This refers to relationships and interactions between multiple entities. This could refer to how a group of local entities gives rise to a global perception or to how one entity acts toward or interacts with another entity. The latter class typically takes the form of "subject-verb-object" such as "the monkey grasps the raisin" or "the girl shoved the boy." Activity here allows us to CEE "how" and "where" events that involve multiple entities are unfolding. Finally, entity-level and scene-level information may be integrated into the middle gestalt cortex, primarily focused on TPJ, generating *psychological-level coherence.* This refers to the psychological meaning and implications of the states of the entities and their interactions. If scene-level coherence is comparable to stage directions describing the physical locations and actions in a scene, psychological coherence refers to the narrative significance of the scene. Activity here allows us to CEE "why" entities are doing what they are doing and what they may do next based on their psychological state (Koster-Hale & Saxe, 2013; Spunt et al., 2010; Spunt & Lieberman, 2012a, 2012b).

## Proposition 1: CEEing Occurs in Gestalt Cortex

As discussed above, CEEing refers to processes that involve conscious effortless coherence. This section will evaluate the evidence that bears on the second half of proposition 1 that links CEEing processes to gestalt cortex (*P1*). This overall proposition will be evaluated by considering evidence related to the more specific propositions that gestalt cortex is associated with conscious

processes (*P1.1–P1.3*), effortless processes (*P1.4)*, and processes that yield coherence (*P1.5*).

To be clear, this review is not suggesting that gestalt cortex (a) is the only area of the brain that contributes to CEEing; (b) is monolithic and thus homogenous in its functionality across subareas, or (c) is involved in no other kinds of processes or computations. Rather, this review suggests that gestalt cortex meets the primary CEEing criteria of conscious effortless coherence across a variety of different domains that superficially seem quite different from one another. Additionally, the construct of CEEing may provide a higher order characterization that helps organize disparate findings of visual, semantic, and psychological processing at least across the gestalt cortex.

### Proposition 1.1: Gestalt Cortex Is Associated With Conscious Experience

There are two main approaches to the empirical study of the neural correlates of consciousness and they reach substantially different conclusions about the brain regions responsible for consciousness. The *hot zone* approach (Koch et al., 2016) primarily focuses on whether consciousness is present in an individual and the brain regions that are differentially active as a function of its presence or absence. For instance, when people are awakened from non-REM sleep, sometimes they report having just been in a dream state, which is considered a conscious state, and sometimes they report a dreamless state, which is not considered a conscious state. When these two states are compared there is reliable consciousness-linked activity observed throughout the posterior half of the brain (see Figure 5a), described as the hot zone, particularly in posterior parietal, posterior temporal, and occipital regions (Siclari et al., 2017). This finding is consistent with the posterior cortical regions generally observed in "hot zone" studies.

In contrast, the *global ignition* approach examines whether a presented stimulus is consciously identified or not (Dehaene & Changeux, 2011; for a related approach see Brown et al., 2019). Here, a tone or a word would be presented at thresholds where it may or may not be observed. On the trials when stimuli are consciously identified (see Figure 5b), activity increases dramatically in ventral temporal areas and activations spreads, "globally igniting" activity in IPL, PTC, and throughout lateral prefrontal cortex (PFC).

Despite claims from both camps that they have little in common, both approaches typically produce activity spanning gestalt cortex in IPL, PTC, and VTC (see white outlines in Figure 5). One possibility is that in hot zone studies, pre-reflective construals are the highest level of processing that reliably occurs, whereas in global ignition studies, the same pre-reflective construals are being fed forward to PFC areas that can consciously reflect on the cue being present. However, the main point here is that to the extent that either the hot zone or global ignition accounts have merit, gestalt cortex is associated with conscious processes.

In addition to neuroimaging studies, neurological lesion work suggests that TPJ, in middle gestalt cortex, is central to conscious experience. Specifically, unilateral neglect, most often driven by damage in right TPJ, is associated with a loss of awareness of objects or parts of objects present in the left side of one's visual field (Driver & Vuilleumier, 2001). There is residual non-conscious processing of the visual inputs but the parts on the left side of one's visual field never reach consciousness. Additionally, when global grouping cues are provided by an experimenter, the neglect can be overcome (Vuilleumier & Rafal, 1999) suggesting a link between TPJ, gestalt processes, and conscious experience. There is ongoing discussion about which aspects of conscious awareness are altered in neglect (Corbetta & Shulman, 2011; Vuilleumier, 2013) and whether the effects are associated with TPJ, per se, or due to a white matter disconnection between TPJ and the dorsal attention network (Bartolomeo et al., 2007). Regardless, visual "neglect is the purest known disruption of consciousness caused by brain damage"

(Graziano, 2016). Additionally, studies suggest activation of the TPJ may be necessary for some induced forms of conscious experience. Although direct electrical stimulation of visual cortex can produce consciously experienced phosphenes in the absence of visual inputs, this may only occur when neural activity spreads from visual cortex to TPJ (Beauchamp et al., 2012).

In summary, proposition 1.1 appears to be well supported. While there is ongoing debate about which regions outside of gestalt cortex are also associated with conscious experience, both major camps, along with the lesion literature, converge on gestalt cortex being central to conscious experience.

### Proposition 1.2: Gestalt Cortex Is Not Associated With Conscious Thought

Proposition 1.2 suggests that while gestalt cortex is involved in conscious experience, it is not associated with conscious thought. In order to examine conscious thought, in contrast to conscious experience, there are a variety of tasks that one can turn to including working memory, logical reasoning, and mathematical reasoning tasks that all exemplify or support conscious thinking. The general finding across these domains is that they all reliably activate lateral PFC and lateral parietal regions. At first blush, these lateral parietal findings appear problematic for proposition 1.2. Superior parietal lobule (SPL) and intraparietal sulcus (IPS) appear quite frequently, but these regions are outside gestalt cortex. The potential issue stems from the fact that many of the tasks report activations in IPL, a region that makes up most of dorsal gestalt cortex.

A meta-analysis of all types of working memory highlights SPL/IPS regions (Rottschy et al., 2012), however, a more recent meta-analysis focused on verbal working memory also highlights multiple IPL clusters (Emch et al., 2019). A meta-analysis of mathematical operations highlights the involvement of IPS, along with other effects in SPL and IPL (Hawes et al., 2019). This is consistent with work on solving algebraic equations that reports parietal

**Figure 5**
*Neural Correlates of Consciousness*

(A)



(B)
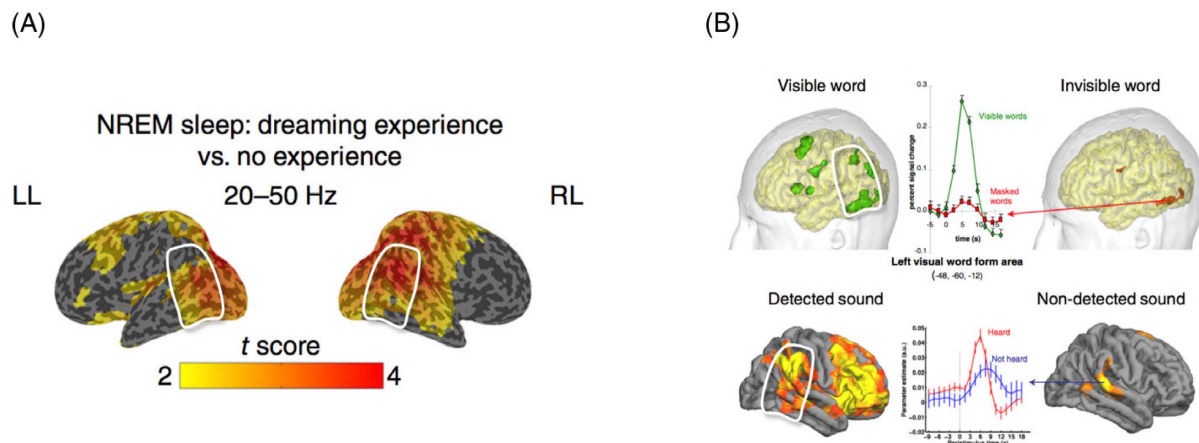


*Note.* Panel (a) Regions more active during sleep considered conscious because of the presence of dreams compared to nondreaming sleep (from Siclari et al., 2017). (b) Regions are more active when a stimulus is consciously detected compared to undetected stimuli (from Dehaene & Changeux, 2011). White outlines added to indicate the approximate location of gestalt cortex. See the online article for the color version of this figure.

activations across this anatomical span (Danker & Anderson, 2007; Monti et al., 2012; Terao et al., 2004).

Perhaps the most relevant psychological process is logical reasoning and here there are several different meta-analyses examining different types or subtypes of reasoning. Whether it is reasoning in general (Wendelken, 2015), deductive reasoning (Prado et al., 2011; Wang et al., 2020; Wertheim & Ragni, 2018), inductive reasoning (Wertheim & Ragni, 2018), analogical reasoning (Hobeika et al., 2016), syllogistic reasoning (Wertheim & Ragni, 2020), or conditional reasoning (Wertheim & Ragni, 2020), activations in SPL, IPS, as well as IPL are common.

Before concluding that IPL, and thus gestalt cortex, is involved in conscious thought, there are two important considerations. First, inspection of the locations of IPL activations indicates that only a small portion of IPL may be involved in conscious thought. Specifically, using a Montreal Neurological Institute brain atlas, IPL runs from a $z$-plane of ∼15 ventrally to a $z$-plane of ∼50 dorsally. Almost every meta-analysis listed above reports IPL activations of $z > 40$, suggesting only a small portion at the top of this region ought to be considered as functionally linked with conscious thought. The majority of IPL along with other parts of gestalt cortex are not associated with working memory, mathematical reasoning, or logical reasoning and thus can be considered distinct from conscious thought.

The second consideration is that working memory, mathematical reasoning, and logical reasoning may recruit experiential processes in addition to thought processes and this might be the source of IPL activations. A subjective construal that is generated through CEEing may serve as an input to a propositional reasoning task. Thus, it is possible that an experiential process that tends to co-occur with conscious thought, may look like it supports conscious thought in a neuroimaging study. To address this, it is important to look at tasks where logical thought and experiential responses are at odds with one another. In these tasks, if IPL is involved in conscious thought, its activity should correlate positively with successful task performance, but if it is more involved in conscious experience then its activity would be unrelated or negatively related to successful task performance.

Numerous neuroimaging studies of belief bias, framing effects, and utilitarian versus deontological moral reasoning all pit conscious thought against conscious experience and provide a test of this idea. Belief bias occurs when a syllogism is obviously untrue, but logically valid (e.g., no inexpensive things are dangerous, cigarettes are inexpensive, therefore cigarettes are not dangerous). Affirming the validity of these syllogisms requires engaging in successful logical thought and overcoming one's immediate experience of this sort of syllogism. This relies on right PFC, but not any part of lateral parietal cortex (Goel & Dolan, 2003; Tsujii et al., 2010). Additionally, cognitive load and time pressure both decrease the right PFC response and increase the frequency of the belief bias strongly linking this region to effortful conscious thought (Tsujii & Watanabe, 2009; Tsujii & Watanabe, 2010).

Similar to the belief bias, when people make utilitarian moral judgments (e.g., saving as many people as possible) rather than a deontological/emotional judgment (e.g., refusing to personally kill one person to save the others), there is lateral PFC activity (Greene et al., 2001; Shenhav & Greene, 2014). The fact that this effect is diminished when people are under cognitive load suggests that this kind of reasoning depends on effortful conscious thought (Greene et al., 2008). In contrast, when people make the deontological/personal judgment, there is increased activity in IPL and medial parietal regions (Greene et al., 2001; Shenhav & Greene, 2014). Consistent with the notion that deontological/personal judgments are guided by immediate experience, evidence suggests that visual imagery contributes to deontological/personal judgments, but not to utilitarian judgments (Amit & Greene, 2012).

Neuroimaging studies of framing effects tend to invoke either gain/loss framings (i.e., how many will survive vs. how many will die) or status framings (i.e., this piece of art hangs in the Museum of Modern Art or at an adult education center). Across these studies, overcoming framing effects is most consistently associated with lateral prefrontal regions (Aydogan et al., 2018; De Martino et al., 2006; Smith et al., 2015; Zheng et al., 2010). In contrast, susceptibility to the immediate experience of the framing is most often associated with activity in TPJ/IPL (Deppe et al., 2005; Liu et al., 2020; Silveira et al., 2015; Smith et al., 2015).

Together, these studies on belief bias, moral reasoning, and framing effects suggest that IPL activations may reflect immediate experience, which is either used by or overcome by conscious thought processes, depending on the task. That said, based on the location of IPL activations during working memory, logical reasoning, and mathematical reasoning, it is prudent to restrict gestalt cortex to the IPL region below a $z$-plane of 40. Indeed, it is because of these findings that the upper boundary of gestalt cortex stops short of the uppermost part of IPL. When gestalt cortex is restricted this way, there is strong evidence for proposition (P1.2) that gestalt cortex is not involved in conscious thought.

### Proposition 1.3: Non-Conscious Processes That Do Not Influence Conscious Experience Occur Outside Gestalt Cortex

Having established the gestalt cortex is involved in conscious experience (P1.1), but not conscious thought (P1.2), the next question is whether gestalt cortex activations reflect non-conscious processes that remain non-conscious and do not impact conscious experience. Proposition 1.3 suggests that it will not. Here, the focus is on subliminal presentations that might alter a behavior (e.g., reaction time) or produce a neural response without the participant ever being aware of the presentation and without the subliminal presentation impacting the construal of a consciously perceived stimulus that follows. The CEEing model assumes that pre-reflective construals are influenced by many non-conscious processes, but here we focus only on those non-conscious processes that do not impact these construals to determine if they occur in gestalt cortex.

Perhaps the best-known finding from the neuroimaging literature on non-conscious processes is that the amygdala is sensitive to the emotional valence of subliminally presented faces (Morris et al., 1998; Whalen et al., 1998). Across the entire brain, a meta-analysis of subliminal presentations of emotional faces indicates reliable effects in amygdala, anterior cingulate cortex, and occipital cortex (Brooks et al., 2012). None of the reported effects were in gestalt cortex and this was also true for other meta-analyses from the same article on subliminal visceral stimulation and subliminal verbal stimuli.

Face processing is the most likely candidate to produce gestalt cortex effects during subliminal presentation given that humans appear to have specialized processing for faces (Kanwisher, 2010) and this processing occurs in the FFA which is in the VTC component of gestalt cortex. Indeed, a number of neuroimaging studies using subliminal presentation methods report either FFA activity or N170 electroencephalogram (EEG) effects, which are believed to face specific and emanate from FFA (Jiang & He, 2006; Moutoussis & Zeki, 2002; Sterzer et al., 2008, 2009; Suzuki & Noguchi, 2013). At the same time, twice as many studies report *not* finding these effects in FFA (Fisch et al., 2009; Harris et al., 2011, 2013; Jiang et al., 2009; Kume et al., 2016; Levinson et al., 2021; Navajas et al., 2013; Reiss & Hoffman, 2007; Rodríguez et al., 2012; Shafto & Pitts, 2015).

The first relevant issue across these studies is the sample size differences. Those that show FFA responses to subliminal faces have an average sample size of $n = 7.7$, whereas those who do not show the effect have an average sample size of n = 23. Very small samples tend to produce extreme, unreliable effects. Additionally, another distinguishing feature of studies that do or do not report FFA responses is the technique used to render the faces "invisible" (Axelrod et al., 2015). Specifically, studies using backward masking, sandwich masking, object substitution masking, and inattentional blindness techniques all typically report no differential FFA response to invisible faces compared to invisible nonfaces. In contrast, almost all of the positive findings of FFA to invisible faces come from studies using continuous flash suppression (CFS).

CFS is a relatively new technique (Tsuchiya & Koch, 2005) that can render a stimulus subjectively invisible for up to several seconds in contrast to other techniques that require extremely short presentation times. CFS is the preferred technique for many of the recent "Yes it can" studies (Hassin, 2013) that suggest that processes assumed to require conscious thought can actually occur without conscious awareness. This technique has been used to suggest that complex processes like sentence reading (Sklar et al., 2012), subtracting two numbers (Sklar et al., 2012), and integrating elements of a scene (Mudrik et al., 2011) can occur without conscious awareness, though more recently there have been high powered replications that failed to reproduce each of these effects (Hesselmann & Moors, 2015; Moors & Hesselmann, 2019; Moors et al., 2016; Rabagliati et al., 2018).

It is a bit of an anomaly as to why CFS studies have produced FFA activity to invisible faces when several other methods have not, particularly when CFS is thought to suppress inputs more than other methods (Breitmeyer, 2014). However, there is mounting evidence that participants in CFS studies may have some conscious awareness of the stimuli but that this awareness may be obscured by statistical and methodological procedures (Sterzer et al., 2014; Vadillo et al., 2020; Lin & Murray, 2014; Yang et al., 2014). If CFS procedures are overlooking some degree of conscious awareness, then these FFA findings may be false positives rather than true findings.

In sum, while the CFS studies may provide some potential evidence for the FFA region of gestalt cortex supporting non-conscious processes that are never integrated into conscious experience, the vast majority of studies do not find this effect and there is reason to worry that the CFS studies have relied on underpowered samples and are inducing awareness that is undetected by experimenters. Combined with other studies of subliminal processing reviewed in this section, the current state of this literature provides mostly supportive evidence

for the claim that gestalt cortex is not associated with non-conscious processes that remain non-conscious (*P1.3*). At this point, the best evidence suggests this type of non-conscious process is associated with activity in amygdala, insula, anterior cingulate cortex, and ventral occipital cortex.

## Proposition 1.4: Gestalt Cortex Is Associated With Effortless Rather Than Effortful Processes

Proposition 1.4 of the CEEing model suggests that processes occurring within gestalt cortex should feel effortless and that as effort and cognitive load increase, activity should increase in regions outside of gestalt cortex. There is not much literature devoted to processes that feel effortless, per se. It is likely that the processes examined in the next section on coherence tend to feel effortless and thus bear on this proposition (*P1.4*), but here it suffices to note two things. First, it is generally assumed that increased levels of cognitive load are associated with increased effort (Ayres, 2006; Leppink et al., 2013). This assumption is sufficiently strong that most studies that report on effort have not assessed subjective effort, but instead assume that manipulations of load level are tantamount to manipulating effort. Thus, in line with proposition 1.4, as working memory load parametrically increases, the brain regions whose activity follows suit are all outside of gestalt cortex (see Figure 2 in Rottschy et al., 2012). Similarly, it is well-established that as task difficulty (and presumably effort) *decreases*, there is greater activity across wide swath of gestalt cortex including IPL, PTC, and VTC (Jansma et al., 2007; McKiernan et al., 2003; Pallesen et al., 2009). In other words, increased task load is associated with increased activity outside gestalt cortex and decreased task load is associated with increased activity inside gestalt cortex.

Nevertheless, none of the above studies specifically assess effortlessness. Perhaps the closest would be a small number of studies that have assessed "flow" which has been described as a state of effortless control, when one's skills are well matched with the challenge of a task, allowing one to "get into the zone." Most of these studies (Barrett et al., 2020; Ferrell et al., 2006; Ulrich et al., 2014, 2016; cf. Huskey et al., 2018) show some increases in gestalt cortex during the flow state, often relative to both harder and easier tasks. However, some of the same studies also show other parts of gestalt cortex decreasing in activity during flow (Ulrich et al., 2014, 2016). While these flow studies might be closer to examining effortlessness than other studies, they are still imperfect as they tend to examine motor tasks rather than subjective construal processes.

Overall, the evidence for proposition 1.4 is strong with respect to the claim that effortful processing occurs outside of gestalt cortex and moderately strong with respect to the claim that processing associated with gestalt cortex feels effortless. The next section provides additional support for this proposition.

## Proposition 1.5: Coherence via Integration Across Multiple Psychological Elements Occurs in Gestalt Cortex and With Conscious Experience

There are multiple lines of inquiry relevant to the kind of coherence posited in the CEEing model such as gestalt processing and multisensory integration. In each of these cases, an individual's conscious perception seems to effortlessly generate a coherent

experience of the sensory inputs that goes beyond what is objectively present in or indicated by those sensory inputs (*P1.5*). Consequently, the results of such studies do not reflect pure sensory processing, but the coherence brought to those sensory inputs.

The first neuroimaging studies of coherence were in the domain of illusory contours in which coherent shapes are consciously experienced even though they are not present (see Figure 6a). Early studies of illusory contours pointed to occipital region V2 as filling in the overall shape relative to when real contours are shown (Seghier & Vuilleumier, 2006). However, most of these early studies only reported on the occipital activations. Illusory contour studies that do examine activity outside of V1/V2 typically also report gestalt cortex activity in the IPL and LOC (Foxe et al., 2005; Larsson et al., 1999; Murray et al., 2004; Murray, Wylie, et al., 2002; Shen, Zhang, & Chen, 2016; Stanley & Rubin, 2003; Tivadar et al., 2018). One model suggests that lower visual areas reconstruct the missing contours, whereas IPL and LOC may be more involved in the global perception of illusory contour figures (Seghier & Vuilleumier, 2006). Of note, a patient with damage to LOC but spared V1/V2 was not able to see illusory contours (de-Wit et al., 2009). Additionally, an EEG study found that the earliest discrimination of illusory contours from control stimuli occurred in gestalt cortex, first in TPJ followed by LOC, and then finally in V1/V2 (Knebel & Murray, 2012).
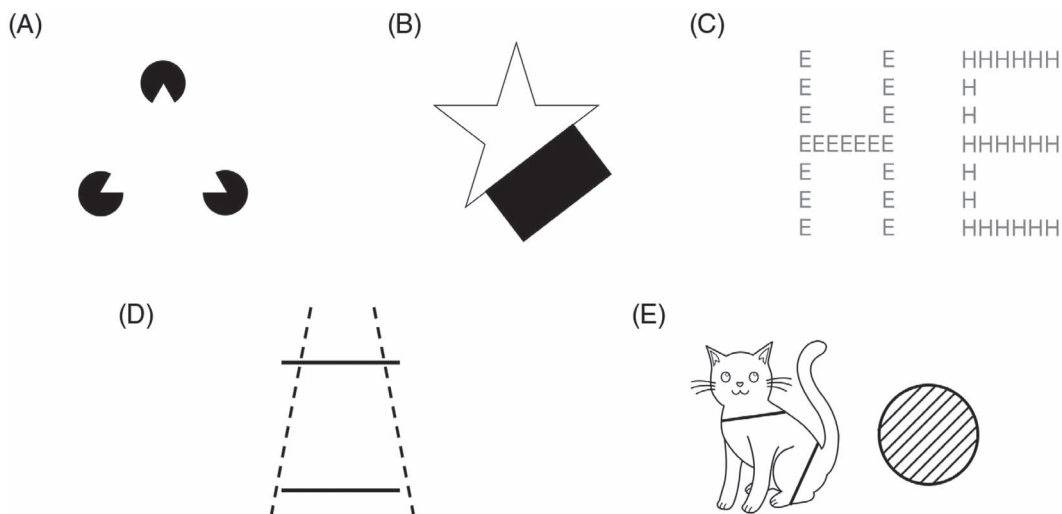
Amodal completion is similar to illusory contours in which an entire object is "seen" even though an entire object is not presented. For instance, the object in Figure 6b could be an irregular four-pointed object abutting a black rectangle, but typically we see this as a five-pointed star that is partially occluded by the rectangle. Occluded objects and faces that are perceived as complete are associated with

gestalt cortex activation in LOC and FFA, respectively (Thielen et al., 2019). IPL in dorsal gestalt cortex is also present in several studies of amodal completion (Thielen et al., 2019) and in some cases temporally precedes activity in VTC regions (Chen et al., 2009; Sehatpour et al., 2006). It is unclear whether early visual areas contribute to this process (Thielen et al., 2019).

Note that the effortless coherence associated with the kinds of images in Figure 6a and 6b already suggest how naïve realism could arise. The illusions created by each of these images are very compelling such that we feel that we are seeing a triangle or five-pointed star that is really out there in the world, rather than being a subjective construal that clearly deviates from reality. It is very hard to imagine anyone not seeing what we see, because it feels like we are seeing reality, rather than constructing it. In the case of these illusions, nearly everyone sees them the same way because our brains engage in the same sort of coherence generating processes from the sensory inputs. But in cases where our effortless constructive processes differ, we may have the same sense of "seeing reality," but not have the same construals as others.

In the domain of global processing (see Figure 6c), either a global or local percept can be seen, typically with the larger percept being composed of smaller elements. Both fMRI and transcranial magnetic stimulation (TMS) studies have pointed to two regions involved in global perception in these studies: IPS just outside gestalt cortex (Grassi et al., 2016, Romei et al., 2011; Zaretskaya et al., 2013) and TPJ in middle gestalt cortex (Bloechle et al., 2018; Huberle & Karnath, 2012; Nestmann et al., 2020; Rennig et al., 2013; Rennig et al., 2015; Ritzinger et al., 2012; Weidner & Fink, 2007). Note that gestalt processing of auditory rhythms was also associated with TPJ in a multivariate classification study (Notter et al., 2019). Given its role

**Figure 6**
*Global Coherence Stimuli*



*Note.* Panel (a) Kanizsa figures that produce illusory contours (b) Amodal completion in which the black rectangle appears to occlude a complete star (c) An example of hierarchical stimuli, Navon letters, in which a global letter is made up of a different smaller letter (d) Ponzo illusion in which the two horizontal lines appear to be different lengths due to the integration of the contextual dashed lines (e) Stimuli that are difficult for simultagnosics including a cat (left) with artificial segmentation and (right) a stimulus for which simultagnosics can either see the shape or the diagonal lines.

in the dorsal attention network, it is plausible that IPS is more central to intentionally attending to the global form, rather than actually constructing the global perception itself (Weissman & Woldorff, 2005). In contrast, a study using Ponzo illusion stimuli (see Figure 6d) suggests the TPJ is central to integrating the local elements into a global percept during pre-reflective processing, even in the absence of attention (Carther-Krone et al., 2020). This finding speaks to the effortlessness of TPJ's contribution.

In multisensory integration studies, verbal and auditory cues are typically effortlessly integrated into perception such that one sensory channel essentially overrides the objective inputs to the other. In the McGurk effect, seeing a face mouthing different sounds (McGurk & MacDonald, 1976), influences how an unchanging stream of audio syllables is heard. For instance, if the audio of a speaker saying "ba ba ba" is played while the video shows the individual mouthing "fa fa fa," the person watching will unambiguously hear "fa fa fa." The McGurk effect has been reliably associated with gestalt cortex region pSTS, posterior to primary auditory cortex (Beauchamp et al., 2010; Erickson et al., 2014; Jones & Callan, 2003; Szycik et al., 2012; also see Davies-Thompson et al., 2019). The sound-induced flash illusion (Shams et al., 2005) is another multisensory integration phenomenon that occurs when the presentation of a single flashed stimuli accompanied by two beeps in quick succession is experienced as two, rather than one, flashed stimuli. TMS over IPL in gestalt cortex has been shown to disrupt this phenomenon (Kamke et al., 2012). Similarly, the ventriloquism effect, in which a sound's location is biased toward a visible potential source, is associated with pSTS/TPJ (Bischoff et al., 2007). These results are consistent with the general view that regions within gestalt cortex are critical to integration and cross-modal binding of auditory, visual, and tactile stimuli (Stein & Stanford, 2008).

Finally, early neuropsychological work on simultagnosia (Bálint, 1909; Wolpert, 1924) points to a strong connection between gestalt cortex region IPL and effortlessly bringing coherence to the visual world. Simultagnosia is a rare disorder associated with deficits in processing multiple objects or features of objects together and has been localized primarily to IPL (Chechlacz et al., 2012; Dalrymple et al., 2013; Himmelbach et al., 2009). A recent review described the disorder as leaving "a patient's world unglued" (Dalrymple et al., 2013, p. 1) much like the opening example in this article. When presented with multi-item arrays, simultagnosics tend to only see one of the objects and when presented with hierarchical stimuli they tend to experience only the local components (and even those only one at a time) but not the global aspect (Dalrymple et al., 2007; Huberle & Karnath, 2006; Karnath et al., 2000). When presented with illusory contours, they tend not to see the implied shape (Barton et al., 2007). Sometimes, simultagnosic patients even have difficulty with different attributes within the same object. One patient shown objects that had a series of diagonal stripes (see Figure 6e) could either see the overall shape or the texture fill, but not both (Coslett & Lie, 2008). Other patients could not make sense of a cat drawing when it included artificial segmentation (see Figure 6e; Riddoch & Humphreys, 2004). In general, gestalt cortex-linked simultagnosia is associated with a failure to effortlessly integrate multiple elements from a scene into a single coherent experience.

This section provides strong evidence that gestalt cortex is associated with integrative coherence processing (P1.5). It also provides further evidence for the claim that gestalt cortex processes feel effortless (P1.4).

## Proposition 2: CEEing in Different Domains (Visual, Semantic, and Psychological) Are Each Associated With Gestalt Cortex

The above review suggests there is a substantial amount of evidence associating gestalt cortex with CEE (P1). This section will now examine whether processes that meet the criteria for CEEing across the visual ("seeing matter"), semantic ("seeing meaning"), and psychological ("seeing mind") domains each occur within gestalt cortex (P2).

### Seeing Matter

When examining CEEing in the context of seeing the physical world (i.e., conscious experience of real objects in context or in motion), it is critical to distinguish between visual processes that perform preliminary analyses of visual inputs and those processes associated with experienced outputs of perception. The former we might call *visual preprocessing*, whereas the latter are acts of CEEing. Preprocessing refers to the preliminary non-conscious steps the visual system takes to detect various aspects of the inputs coding for things like textures and contours without producing a conscious experience of an integrated object or scene.

The simplest act of visual CEEing involves consciously recognizing objects. Evidence strongly suggests that occipital visual areas like V1 and V2 perform visual preprocessing but do not represent full coherent objects or contribute to their conscious experience (Dumoulin, 2015; Rees et al., 2000). In contrast, gestalt cortex region LOC represents complete objects and is associated with their conscious experience (Bar et al., 2001; Grill-Spector et al., 2001). This is a highly efficient conscious process as evidenced by the fact that as soon as visual presentations are long enough to allow for any recognition that something has been seen, the person also consciously recognizes the category of object that has been presented (Grill-Spector & Kanwisher, 2005).

Category selective cortex, representing different objects, faces, bodies, places, and words is distributed throughout ventral gestalt cortex in VTC (Grill-Spector & Weiner, 2014; Kanwisher, 2010). Category selective processing here meets the criteria of CEEing in terms of typically being conscious, effortless, and coherently integrated perceptual acts (P1). For instance, as described above in the section on proposition 1.3, there is some debate about whether faces presented outside of conscious awareness can produce activity in FFA at all. However, even in those studies that suggest it does, conscious processing of faces produces dramatically more activation in FFA than non-conscious processing (Jiang & He, 2006; Sterzer et al., 2009). Additionally, faces are processed configurally, as integrated wholes, and when the configuration is altered, as in an upside-down face, processing is far less efficient (Diamond & Carey, 1986). Critically, configural processing of faces only occurs for consciously perceived faces (Axelrod & Rees, 2014; Chen & Yeh, 2012; Suzuki & Noguchi, 2013) suggesting that the configural integration and conscious processing are linked (P1.5).

As motion is added to the equation, other gestalt cortex regions in PTC and aIPS become central to CEEing. Area hMT+ in middle temporal gyrus within PTC is known to be selective for motion as it is consciously experienced (Tootell et al., 1995). Additionally, hMT+ is surrounded by body and face-selective regions (EBA) that are sensitive to bodies in motion (Downing et al., 2001;

Grill-Spector & Weiner, 2014; Ma et al., 2018), unlike the category-selective regions in VTC, which are insensitive to motion. Within the inanimate world, intuitive physics represents the highest experienced level of motion-based complexity. Fischer et al. (2016) conducted a series of studies and found that processing of intuitive physics engaged multiple gestalt cortex regions along with the supplemental motor area and SPL.

Socially communicative biological motion, such as lip and eyebrow movement, tends to be represented in pSTS in middle gestalt cortex (Pelphrey et al., 2005). Like FFA for faces, pSTS processes biological motion configurally. TMS applied to pSTS impairs processing of upright biological motion, but not inverted biological motion (Grossman et al., 2005) implying the pSTS is sensitive to the coherence across elements when presented in the typical format (i.e., upright). Some evidence suggests EBA may also process biological motion configurally (Thompson et al., 2005). Finally, aIPS in gestalt cortex, along with the premotor cortex are the only regions involved in conscious but effortless processing of observed goal-directed actions (Spunt & Lieberman, 2013). Biological motion and action perception will be discussed more below as they assist in the transition from seeing matter to seeing minds. Also note that while spatial cognition is partly associated with IPL, it appears to be substantially more associated with parietal regions dorsal to IPL (Sack, 2009). Thus, spatial cognition may be less linked to gestalt cortex than other aspects of effortless conscious processing of the physical world.

The results of this section suggest that when we consciously construe the combination of visual elements to be a familiar object or construe multiple entities to be interacting with each other, this depends on gestalt cortex (P1, P2). Such effects were observed in gestalt cortex regions including FFA, LOC, pSTS, and aIPS. Additionally, the coherence studies presented in the previous section that produced IPL/TPJ effects were also studies of visual experience. Traditional visual regions of the brain in occipital cortex may be better characterized as visual preprocessing, preparing representations that gestalt cortex can operate on in the construction of coherent effortless experience.

## Seeing Meaning

Just as IPL in gestalt cortex may represent a top level of the hierarchy for effortless integration of visual inputs related to CEEing the physical world (Himmelbach et al., 2009), IPL also represents a top level of the processing hierarchy for language-based semantic processing as well. A meta-analysis of the neural bases of language-based semantic processes (Binder et al., 2009) identified the AG in IPL, which overlaps with TPJ, as one of the major hubs for semantic processing, along with anterior temporal lobe (ATL) and left inferior frontal gyrus. Multiple approaches to semantic processing each suggest that the AG/TPJ region of gestalt cortex supports semantic processes that have the same characteristics as CEEing more generally. More specifically, semantic processes in AG/TPJ tend to be more relationally integrative across multiple words and concepts, rather than focusing on the semantic meaning of words and concepts in isolation (P1.5).

Starting at the level of word pairs, semantic relatedness can be divided into *taxonomic* and *thematic* associations (Mirman et al., 2017). Dogs and whales are taxonomically related because they are both members of the category of "animal." In contrast, dogs and

leashes are thematically related because they are typically present in the same spatiotemporal context (i.e., dog walking). One could argue that thematic associations are more central to everyday semantic processing as they deal with entities that tend to co-occur in coherent natural events and situations, whereas taxonomic associations are more relevant to an abstract understanding of how the world is categorically structured. Evidence from a variety of sources suggests that ATL, outside gestalt cortex, is more involved in taxonomic processing, whereas AG/TPJ, within gestalt cortex, is more involved in thematic processing. This result has been consistently found in studies examining fMRI activation (Boylan et al., 2017; Jackson et al., 2015; Lewis et al., 2019), fMRI adaptation (Geng & Schnur, 2016), representational similarity analysis (Xu et al., 2018), TMS modulation (Davey et al., 2015), and lesions (Mirman & Graziano, 2012, Schwartz et al., 2011). Although these studies have uniformly focused on conscious associations, multiple studies point to thematic processing in AG/TPJ also occurring effortlessly (P1.4; Davey et al., 2015; Estes et al., 2011, Sass et al., 2009, Wamain et al., 2015). Additionally, using Navon letters (Figure 6c) to prime a global, rather than local, mindset induces greater thematic, relative to taxonomic, processing (Guest et al., 2016), suggesting that thematic processing is naturally aligned with coherence processing. Thus, thematic semantic processing within gestalt cortex appears to occur consciously and effortlessly, while doing so in a manner that is holistic, relational, and integrative.

Combinatorial semantics move up to a higher level of integration, focusing on the meaning of multiword phrases or full sentences. Just as in gestalt perception, the meaning of individual local elements (i.e., words) are changed and constrained as they are combined with one another. There are many kinds of cars, but the phrase "toy car" constrains the universe of cars denoted. Several studies (Bemis & Pylkkänen, 2013; Graves et al., 2010; Price et al., 2015, 2016) have looked at meaningful two-word pairs relative to control word pairs and reliably observed AG contributions. For instance, in one study (Price et al., 2015), AG was the only region of the brain that responded more to meaningful word pairs ("plaid jacket") than nonmeaningful word pairs ("moss pony"). A follow-up tDCS study (Price et al., 2016) observed that anodal stimulation of AG facilitated responding to the meaningful, relative to the nonmeaningful, word pairs.

A number of studies (Bavelier et al., 1997, Humphries et al., 2007, Pallier et al., 2011) have also highlighted AG/IPL's role in processing the semantic meaning of longer phrases or sentences. Pallier et al. (2011) presented 12 real or pseudo words in quick succession. The presentations consisted of two, three, four, six, or 12-word phrases. AG was one of only two brain regions whose activity increased as meaning had to be integrated over more words, while not responding to an increasing number of pseudo words. Another study found that AG was the only semantic region that responded more to meaningful sentences than to meaningless sentences or word lists constructed from the words in the meaningful sentence presented in randomized order (Humphries et al., 2007).

The highest level of coherent meaning from language is present in multisentence discourse. Early fMRI studies in this domain examined series of sentences that together have coherent meaning or not. One study either presented stories intact, all the story's sentences in a scrambled order, or all the story's words in a scrambled order (Xu et al., 2005). TPJ showed increases from baseline to words, from words to sentences, and from individual sentences to full

discourse and was one of the only regions more active for the discourse level than the sentence level. Another study (Martín-Loeches et al., 2008) utilized the Bransford and Johnson (1972) paradigm to present participants with passages that were only effortlessly sensible if they were also presented with the topic. The largest cluster more active during labeled, than unlabeled, passages was an AG region near the TPJ cluster found by Xu et al. (2005). Finally, Egidi and Caramazza (2013) examined the processing of sentences at the end of paragraphs. These sentences could conflict or not with the previous sentence (i.e., local context) and be relevant or not to the overall focus of the paragraph (i.e., global context). IPL in gestalt cortex was the only region of the brain sensitive to both of these contextual levels as well as their interaction (also see Branzi et al., 2020).

Overall, the studies of thematically related words, combinatorial semantics, meaningful phrases, and multisentence discourse all suggest that AG, within gestalt cortex, is critical to conscious "integration of semantic information into an ongoing context" (Humphries et al., 2007). Construal of meaning from language thus depends on the IPL region of gestalt cortex (*P1*). That the same could be said with respect to visual processing suggests that this region is doing something important for very distinct kinds of seeing (*P2*).

### Seeing Minds

Mentalizing is the process of making sense of the psychological states of others and is generally thought to depend on medial prefrontal regions (MPFC) and TPJ, with support from posterior medial cortex (PMC) and ATL (Fletcher et al., 1995; Lieberman, 2010; Van Overwalle, 2009). Although mentalizing is generally discussed in terms of explicit thinking or reasoning about mental states (e.g., Theory of Mind; ToM), more recent work suggests that a significant portion of mentalizing either depends on or is fully realized in terms of psychological CEEing. That is, we often look at others and have the immediate sense of knowing what they are feeling, wanting, or planning without any intervening reasoning on our part. That the same gestalt cortex region, IPL/TPJ, would be involved in effortless high-level integration of visual, semantic, and psychological processing is hard to reconcile outside of an account like CEEing (*P2*).

TPJ is one of two regions most expanded in the human brain compared with macaques (Van Essen & Dierker, 2007) and is particularly well-positioned to integrate various inputs from other regions within gestalt cortex in order to produce this pre-reflective experience of psychological CEEing. Figure 7 displays a schematic of all gestalt cortex connectivity pathways (see also, Patel et al., 2019).

Together, these connections suggest that TPJ has easy access to integrated information from other gestalt cortex regions regarding person and object identity via FFA and LOC, how these entities are moving via LOTC, how these entities are interacting (e.g., a person reaching for an object) via aIPS and rostral IPL, the low-level intentions behind observed actions via aIPS (Hamilton & Grafton, 2006), and biological motion via pSTS. When this is combined with thematic semantic processes in AG/TPJ that code for the functional relationships between different entities, this suggests TPJ is immersed in a rich assemblage of high-level data points that are represented in an efficient experiential code. In other words, TPJ is well-positioned to perform a first pass, pre-reflective assessment of

**Figure 7**

*Connectivity Pathways in Gestalt Cortex Providing Inputs to TPJ/IPL*
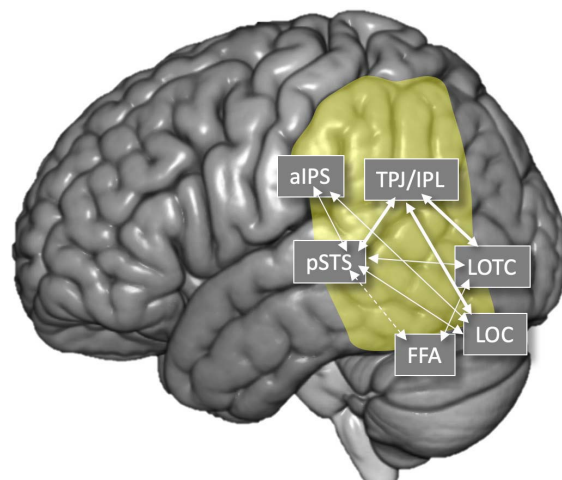


*Note.* Thick white arrows represent established white matter tract connections. Thin white arrows represent functional connectivity. The dashed arrow represents a hypothesized pathway for which the data is equivocal. TPJ receives direct input from pSTS, which represents biological motion, via the middle longitudinal fasciculus (Burks et al., 2017; see also Cheng et al., 2018; Igelström et al., 2015; Igelström & Graziano, 2017; Makris et al., 2013). TPJ also receives direct input from LOTC, which represents objects, bodies, and faces in motion, from the posterior arcuate fasciculus (Bullock et al., 2019; Weiner & Zilles, 2016) and the horizontal portion of the superior longitudinal fasciculus (Martino et al., 2013). These same white matter tracts also connect LOC to TPJ. Although FFA, supporting face processing, and aIPS, supporting action understanding do not have known direct inputs to TPJ, they each can pass information to TPJ, via another intermediary in gestalt cortex. Functional connectivity between aIPS and pSTS has been well-established (Borra et al., 2008; Mars et al., 2012; Patel et al., 2019; Vossel et al., 2014; Wen et al., 2012). Although pSTS would be a natural point of connection for FFA, the data has been very mixed with several studies showing no connectivity (Furl, 2015; Gschwind et al., 2012; Pyles et al., 2013; Zhang et al., 2016) and others showing evidence of this linkage (Habas et al., 2011; Handwerker et al., 2019; Turk-Browne et al., 2010). Regardless, FFA also connects to LOTC (Furl, 2015; Ma et al., 2018; Pyles et al., 2013) which in turn connects to TPJ directly and also indirectly via pSTS (Habas et al., 2011; Lingnau & Downing, 2015). Finally, for the sake of completeness, there is also evidence that aIPS is connected with LOTC (Borra et al., 2008) and that LOC is connected with pSTS (Habas et al., 2011). Abbreviations are given in Figure 4. See the online article for the color version of this figure.

the psychological significance of observed social behavior and interactions. TPJ is actually the region in the lateral posterior part of the brain that is maximally distant from preintegrated visual, auditory, and sensorimotor inputs (Margulies et al., 2016), making it close enough to those inputs to get them efficiently (Tan et al., in press), but also allowing for maximal integrative processing without moving to more distant parts of the brain like the PFC. While ventral gestalt cortex codes for "who" and "what" entities are present and dorsal gestalt cortex codes for "where" and "how" these entities interact within a scene, TPJ may integrate across these inputs to code for "why" events are unfolding this way, psychologically speaking (Spunt & Lieberman, 2012a, 2012b). This region may also

contribute to predicting how psychological entities will continue to behave and respond to changes in the scene (Koster-Hale & Saxe, 2013; Tamir & Thornton, 2018).

Although TPJ is commonly discussed as being critical for *reasoning* about others' mental states (Saxe & Powell, 2006), implying deliberative effortful cognition, there is mounting evidence to suggest that TPJ and other parts of gestalt cortex are involved in psychological CEEing which would not involve reasoning. Psychological CEEing may serve as an end itself, efficiently coding the mental states of others, or as a critical precursor or input to psychological thinking when more flexible cognition is required than CEEing allows (Apperly & Butterfill, 2009). Multiple lines of evidence suggest that TPJ is better characterized in terms of psychological CEEing than psychological thinking.

First, evidence suggests that all mentalizing tasks rely on TPJ, but that tasks with greater propositional reasoning and other executive processing requirements depend on additional contributions from PFC. A recent meta-analysis of mentalizing tasks (Schurz et al., 2021) shows that all six major classes of mentalizing tasks robustly activate TPJ. These tasks vary in the extent to which they seem to require, effort, intention, and propositional reasoning. For instance, typical false belief tasks, where the false belief is explicitly relevant to the task, would seem to require propositionally representing that an actor has a belief that is distinct from one's own belief and that this belief does not correspond to reality. Additionally, numerous studies have shown a link between false belief task performance and executive or working memory processes (Guajardo et al., 2009; Lin et al., 2010; Powell & Carey, 2017). However, the executive processing required by explicit false belief processing is unlikely to depend on TPJ. When false belief tasks are compared to true belief tasks that do not have the same executive demands, TPJ is similarly activated by both types of tasks (Abraham et al., 2010; Aichhorn et al., 2009; Bardi, Desmet, et al., 2017; Bio et al., 2021; Döhnel et al., 2012; cf. Sommer et al., 2007).[3] Instead, explicit processing of false beliefs tends to activate MPFC and rostrolateral PFC regions more than true beliefs, suggesting these regions may be more important for psychological thinking and other executive demands during explicit false belief processing.

In contrast to false belief processing, consider the social animations task (Klin, 2000) which typically involves watching one or more videos like the one originally created by Heider and Simmel (1944). In these videos (see https://www.youtube.com/watch?v=VTNmLt7QX8E), shapes move around the screen and interact with one another in ways that seem to tell a coherent psychological story. Without any instructions at all, observers typically see the shapes and their movements in terms of personalities with various goals, expectations, and emotional reactions. Although executive demands are likely involved in the retelling of the narrative after the fact, one experiences the video as effortlessly coherent, full of rich psychological meaning. Even when the social animation is watched while under cognitive load, the video is still processed in psychological terms (Misovich, 1996), suggesting this task is best understood in terms of psychological CEEing. When compared directly, false belief tasks recruit much more MPFC than social animations, whereas social animations recruit a wider swath of gestalt cortex including TPJ, PTC, and VTC (M. Schurz, *personal communication*). Thus, the psychological thinking demands of false belief processing

appear to be more associated with prefrontal regions, whereas basic belief processing as well as the psychological CEEing associated with social animations is more linked with TPJ and surrounding gestalt cortex regions.

The current distinction between psychological thinking and psychological CEEing in many ways parallels the dual-process account of Apperly and Butterfill (2009). They argued that the brain has a very efficient system for processing beliefs or belief-like states and a second more flexible system for belief reasoning that deals with complex nuanced scenarios that the first system cannot handle. One of the key concepts they introduce is *registrations* which allow an individual to register person, object, and location relationships. Registrations are like proto-belief representations that do not require propositional content, thus allowing preverbal humans and animals to be able to pass some mentalizing tasks. These registrations would also allow adults to sometimes show sensitivity to the belief states of others under conditions that prevent explicit psychological thinking about these belief states.

Since Apperly and Butterfill's (2009) dual-process model, a variety of implicit or spontaneous Theory of Mind studies has been published. These studies show that adults have at least some mentalizing capacities that bear all the hallmarks of automatic processing in terms of being effortless, spontaneous, unintentional, and uncontrollable. These studies typically present participants with stimuli wherein an actor either sometimes has a false belief or a different perspective from the participant (Nijhof et al., 2016; Samson et al., 2010). Importantly, during the critical trials, the actor's psychological state is irrelevant to the task at hand. In these tasks, eye gaze and reaction time measures suggest that participants (both adults and infants) spontaneously and uncontrollably track the actor's belief despite its task irrelevance. Being presented with a person who has a differing perspective or has witnessed different things than us is enough to cause us to see that person as having a different perspective. This occurs even when the main task has nothing to do with the actor's beliefs, and in several studies, participants report that they were not thinking about the actor's beliefs at any time. In one study (Qureshi et al., 2010), these effects even occurred under cognitive load.

A number of these implicit or spontaneous ToM tasks have now been examined using neuroscience approaches. In neuroimaging studies using fMRI and functional near-infrared spectroscopy (fNIRS) there have been nearly uniform findings that right TPJ tracks the actor's beliefs or belief-like states in the absence of explicit reasoning (Bardi et al., 2017; Boccadoro et al., 2019, Hyde et al., 2015, 2018; Kestemont et al., 2013; Kovács et al., 2014; Ma et al., 2011, 2012; McCleery et al., 2011; Naughtin et al., 2017; Schuwerk et al., 2014; Van Duynslaeger et al., 2007; c.f. Schneider et al., 2014). Similarly, in a handful of lesions, TMS, and transcranial direct current stimulation (tDCS) studies, alterations and modulations of TPJ are associated with corresponding changes in spontaneous ToM (Bardi, Six, & Brass, 2017; Biervoye et al., 2016; Filmer et al., 2019).

While these implicit ToM studies demonstrate that belief-like processing can be effortless and reflect coherent integration across

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[3] This is not to suggest there are no executive demands associated with explicit processing of true beliefs, but they are likely diminished relative to those required for false belief processing (Back & Apperly, 2010).

actors, objects, and locations,[4] it is unclear whether these studies provide any evidence for the third component of CEEing—conscious experience. These studies typically do not ask explicit questions about the actor's beliefs, perhaps for fear of converting an implicit task into an explicit one. Nevertheless, these implicit ToM capacities clearly possess at least two of the three main features of CEEing and are associated with TPJ within gestalt cortex and thus support the possibility that psychological CEEing occurs there.

Other sources of evidence speak to the speed and efficiency of TPJ's contributions to mentalizing relative to MPFC. Given that seeing is faster than thinking, such evidence is further suggestive of TPJ and MPFC being more associated with psychological CEEing and psychological thinking, respectively. For instance, in a recent electrocorticography (ECoG) study (Tan et al., in press), which provides high levels of spatial and temporal resolution, we asked participants to make simple mentalizing judgments (e.g., "my neighbor is honest"—yes or no?). MPFC had both activation onsets and offsets that trailed TPJ by hundreds of milliseconds, with TPJ being the earliest component of the mentalizing system to respond to mentalizing trials. This is more consistent with TPJ performing more preparatory computations that are then fed to MPFC for additional reflective processing, rather than TPJ being the final stage itself. In other words, TPJ may support construing the psychological scene (e.g. representing the thematic linkage of the neighbor and honesty) which then would allow MPFC to interrogate it propositionally.

A handful of EEG studies (Van der Cruyssen et al., 2009; Van Duynslaeger et al., 2007; Van Overwalle et al., 2009) have combined the comparison of spontaneous versus intentional psychological processing with millisecond timing and have yielded results consistent with the other findings reviewed in this section. Across these studies, sentences that behaviorally imply either an actor's goal or trait produced fast spontaneous TPJ activations, whereas MPFC responses either came later or only with intentional processing the psychological implications of these sentences.

Before leaving this section, an attentional account of TPJ merits consideration. The alternative account of TPJ suggests it is part of a ventral attention network that detects unexpected but behaviorally relevant targets and redirects attention to them, in contrast to a dorsal attention network that supports more voluntary allocation of attention (Corbetta & Shulman, 2002; Corbetta et al., 2000). If this account were valid, many TPJ findings from the mentalizing literature could be accommodated by it (Mitchell, 2008). However, this account has been upended by electrophysiological data demonstrating that TPJ responses occur too late after an unexpected target to be the causal driver of reorienting effects (Geng & Vossel, 2013). The originators of the attentional account now suggest that TPJ is a lagging, not a leading, process that may involve "postperceptual updating of internal models of environmental context" (Geng & Vossel, 2013; Patel et al., 2019). This account is largely consistent with a CEEing account of TPJ, as updating one's internal model of the current situation is analogous to forming a new coherent construal. Furthermore, as shown in Figure 8, large-scale reverse inference analyses of TPJ pitting mentalizing directly against attentional reorienting and other accounts of TPJ show little evidence for the attentional reorienting account of the region (Du & Lieberman, in prep; see also Carter & Huettel, 2013).

Although speculative, I am proposing that TPJ helps to organize and integrate the psychological features of situations that are seen or

imagined such that these features pop out like elements in a HUD that would then be as easy to make sense of as objects that differ by color. These features would feel "seen" rather than generated through deliberative thought. Just as a fighter pilot's HUD might tag various objects as "friend" or "foe" in an easily visually digestible fashion, TPJ might experientially tag the perceived mental states of others as well as the psychological relationships between individuals in a situation. Imagine not only color-coding others based on their psychological states, but also seeing thick or thin bands connecting people who have stronger or weaker ties with one another. TPJ may be doing this experientially, but nonvisually. The end result may or may not be accurate and may not incorporate all of the available information, but it would be experienced as a given in much the same way that the sky is experienced as blue.

More broadly, the evidence in this section makes clear that prereflective subjective construals that effortlessly make sense of some of the social and psychological dynamics in a situation rely on gestalt cortex. Thus, in line with proposition 2, construals of the social world and construals of visual and semantic inputs that are nonsocial all rely on gestalt cortex for their immediate sensibility.

### Seeing Minds in Narratives

Virtually all mentalizing studies examine a brief episode or single behavior using a few sentences, cartoon panels, or a short video clip. In real life, we often follow the mental lives of others over much longer time frames that are better characterized as narratives. Here too, gestalt cortex plays a central role and much of the neuroimaging work comes from Uri Hasson's lab.

One approach that the Hasson lab has taken (Baldassano et al., 2017; Hasson et al., 2008; Lerner et al., 2011) identifies brain regions that are sensitive to different timescales of narrative components. These different timescales end up manipulating how much meaningful story can be integrated into coherent components. In these studies, participants watch or listen to stories that are presented forward, backward, or chopped up into pieces and randomly strung together. For instance, in one study (Hasson et al., 2008), 3-min silent videos were broken into short (4 s), medium (12 s), or long (36 s) clips that were reordered randomly. The resulting neural time series data was then reordered to match the order of events in the unedited full story. In other words, if the first 4 s of the video was shown out of order as the fifth segment to a participant, the resulting neural data was reordered so that these neural responses were placed at the beginning of the neural time series prior to analysis. Thus the "correct" time series was artificially recreated after the fact. This post hoc reordering creates data such that the sensory inputs are the same sequence in each, but they vary in the timescale of meaning that can be processed because the overarching narrative elements are presented out of order. V1 produced very similar responses whether it was responding to the full story forward or backward or any of the

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[4] It should be noted that while implicit ToM studies show integration across actors, objects, and locations, no claim is made that most or all relevant cues are always integrated during implicit ToM or psychological CEEing. CEEing generally involves efficient integration of various cues (e.g., seeing a baby looking at and stretching their hand out toward a toy block as reflecting a mental state of wanting), but the limitation of CEEing is that it can only integrate some cues and can only do so in certain ways. Thinking is required for representing actual proposition content and transforming it using functions such as negation.

**Figure 8**
*Temporoparietal Junction (TPJ) Is for Mentalizing*
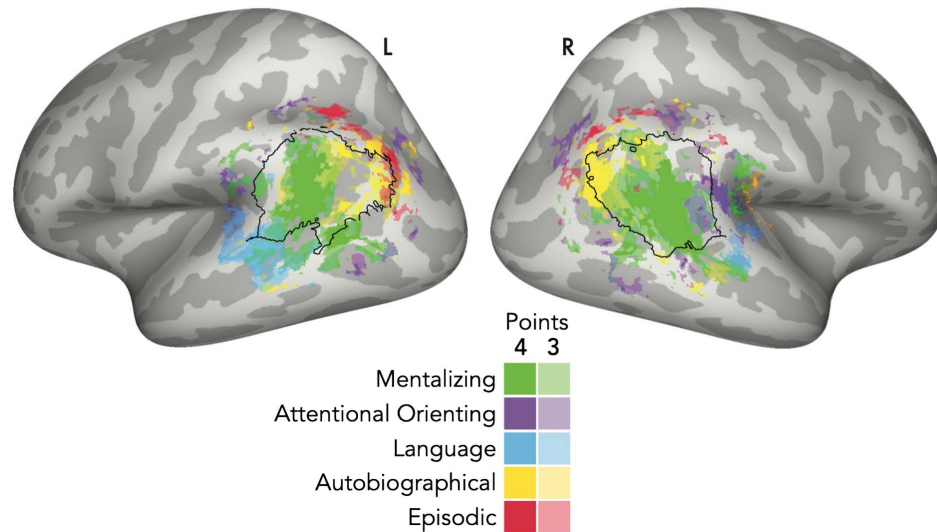


*Note.* We conducted a battle royale reverse inference analysis using NS+ (https://github.com/MetaD/NSplus) which is a Neurosynth-based tool that allows for easy head-to-head comparison of terms (Du & Lieberman, in prep). Here, we compared mentalizing, attentional reorienting, language, autobiographical memory, and episodic memory in head-to-head analyses. For most of TPJ, mentalizing had posterior probabilities above .6 while all other terms were below .4. Points in the legend refer to how many head-to-head analyses a term won in a voxel. Boundaries for TPJ taken from Dufour et al., (2013). See the online article for the color version of this figure.

clip lengths suggesting that this area's responses are largely uninfluenced by the context of preceding content and simply responds to the moment-to-moment visual features of the clip. The highest level of coherent meaning is only present in the long clips and full-length narratives. These longer clips allow context to build up and produce a more integrated narrative meaning. Across all three articles using this approach (Baldassano et al., 2017; Hasson et al., 2008; Lerner et al., 2011), IPL/TPJ in gestalt cortex, along with IPS and PMC outside of gestalt cortex were the only regions that responded selectively to the longer clips that had more integrated meaning across all three articles. Note that such effects only occur when participants are consciously attending to the narrative (Regev et al., 2019). These effects are consistent with proposition 1.5 that gestalt cortex is associated with coherence processing.

Another approach, mostly from the Hasson lab, focuses on amodal aspects of narrative processing. This can be seen in neural synchrony studies examining levels of hierarchical meaning either in auditory-only or visual-only presentations (Hasson et al., 2008; Lerner et al., 2011). Auditory-only narrative presentations produce a hierarchy such that sensitivity to low-level features begins in primary auditory cortex and moves posteriorly to IPL/TPJ, in gestalt cortex, as well as IPS, as higher levels of contextualized meaning are available. Visual-only narrative presentations produce a hierarchy such that sensitivity to low-level features begins in primary visual cortex and moves anteriorly to IPL and IPS as higher levels of contextualized meaning are available. Multiple studies have also

shown that listening to stories told in different languages (English speakers listening in English and Russian speakers listening in Russian), where the sensory inputs are different but the meaning is the same, produces elevated neural synchrony across languages in IPL/TPJ (Dehghani et al., 2017; Honey et al., 2012). Lastly, two studies (Chen et al., 2017; Zadbood et al., 2017) have shown that whether individuals are *watching* a television show, verbally *recounting* the events of the show, or *listening* to someone else verbally recount the events of the show, IPL/TPJ and PMC are the only regions that consistently show neural synchrony across these different ways of engaging the narrative.

These results suggest that high-level narrative processing depends on IPL/TPJ, in gestalt cortex, as well as PMC. One open question is whether this processing is really focused on seeing minds as opposed to narrative understanding, per se. This is because the narratives in the described studies typically focus on the experiences and actions of people, thus confounding the narrative format with the psychological content of the narrative. Straccia et al. (2018) conducted a study that manipulated whether the narrative focused on people or on natural events (e.g., volcanoes) and found that IPL/TPJ was more reliably observed in the psychological narratives and often absent altogether in the natural event narratives. This suggests that IPL/TPJ is contributing to psychological CEEing in the context of narratives, rather than responding to narrative structure, per se.

Within the narrative literature, *situation models* have emerged as an important tool for making sense of narratives and their

psychological elements. Discourse theorists have posited that when we read a story, we represent the story at three levels (Van Dijk & Kintsch, 1983): The surface level represents the specific wording and syntax; the textbase level represents the information of each sentence at the propositional level, and the situation model represents the elements that make a story meaningful (e.g., characters acting with goals and intentions across time and space). Thus, the situation model reflects the coherent meaning of the narrative (i.e., construal of the story) rather than visual or linguistic elements used to convey it and bears a resemblance to the characterization of TPJ in the previous section on seeing minds. Multiple studies have associated situation model processing with TPJ in gestalt cortex (Baldassano et al., 2017; Mano et al., 2009; Yarkoni et al., 2008).

A number of studies have examined whether situation models rely on working memory for tracking how different characters are moving through space and time. There is clear evidence that surface and textbase processing depends on working memory processes (Radvansky & Copeland, 2004). In contrast, multiple studies of situation model processing suggest that accurate construction and updating of straightforward situation models are unrelated to measures of working memory (Radvansky & Copeland, 2004, 2006; Radvansky et al., 2001; cf. Rinck & Weber, 2003). Additionally, while older adults, who have reliably poorer working memory, show impaired performance at the surface and textbase level, they have remarkably spared situation model processing (Hoeben Mannaert & Dijkstra, 2019; Radvansky & Copeland, 2001; Radvansky & Curiel, 1998; Radvansky & Dijkstra, 2007; Stine-Morrow et al., 2002; Tun, 1989). One study combined these two approaches examining working memory capacity in older adults and found no correlation between this capacity and story comprehension (Ehrlich et al., 1994). This work suggests that important aspects of situation model processing of narratives are both integrative and relatively effortless, consistent with this being a form of CEEing in gestalt cortex (P1.4, P1.5).

Some work suggests that other features of situation model updating such as reading time and event-related potentials can vary as a function of trait working memory capacities (Pérez et al., 2015, 2016), but none of these articles have reported an association of working memory with the accuracy of constructed situation models in straightforward narratives. Instead, these articles focus on the introduction of new elements that contradict the existing situation model, rather than further fleshing out it out. Along the same lines, there is also some evidence to suggest that working memory capacity influences accuracy with particularly difficult passages (Dutke & Von Hecker, 2011), but for normal straightforward narratives working memory measures do not correlate with accurate situation model processing. These results suggest that CEEing may be involved in assimilating new information that fits with and extends a situation model, but not when the new details are difficult to integrate into the existing situation model. The latter may require effortful thinking.

In a sense, narrative processing sits at the apex of visual, semantic, and psychological processing as all three occur at their longest timescale in narrative. The evidence clearly points to the IPL/TPJ region of gestalt cortex as centrally involved in integrating meaning across longer timescales, regardless of whether the narrative is presented in words or video, and especially when the narrative focuses on the psychological states and responses of people.

## Proposition 3: CEEing Yields Idiosyncratic Subjective Construals as a Result of the Integration of Sensory and Nonsensory Inputs to Gestalt Cortex

The previous sections have provided substantial evidence that CEEing occurs in gestalt cortex (P1) and does so for visual, semantic, and psychological forms of CEEing (P2). Propositions 3 and 4 move from establishing the existence and neural basis of CEEing to addressing some of the real-world implications of CEEing. Proposition 3 focuses on why we often construe the world differently from one another and how these differences can be tracked in gestalt cortex. Proposition 4 suggests that as our CEEing settles on a single coherent construal of a situation, other construals are effectively inhibited. This helps to explain why we often take a dim view of subjective construal of others, when those construals differ from our own.

### Putting the Subjective in Subjective Construal (P3.1)

According to the CEEing model, subjective construals differ from one another because they reflect the integration of sensory and nonsensory inputs in any given situation. Although sensory inputs can be constrained to be nearly identical across perceivers, nonsensory inputs will often differ potentially leading perceivers to CEE things differently.

An oversimplified schematic model of how sensory and nonsensory processes may influence CEEing in gestalt cortex is shown in Figure 9. The CEEing model assumes, along with modern models of visual perception (Desimone & Duncan, 1995; Freeman & Johnson, 2016; Rao & Ballard, 1999; Yuille & Kersten, 2006), that various sensory and nonsensory inputs constrain one another in an iterative constraint satisfaction-type process (see also Yeshurun et al., 2021). When relevant sensory inputs are unambiguous, it is assumed that they will serve as much stronger constraints on what we ultimately CEE than other nonsensory inputs (P3.1).

Imagine that I have a strong expectation that I will see an elephant behind a closed door, but in fact there is just a bowl of soup waiting for me there. My conscious expectation to see an elephant will not cause me to mistake a bowl of soup for a pachyderm. However, this expectation will activate semantic and perceptual representations that could influence what is seen if the sensory inputs are ambiguous relative to expectations (Chalk et al., 2010, e.g., if a mastodon was waiting, instead of an elephant) and will speed up the identification of an elephant if one was actually waiting there (Pinto et al., 2015). To this end, expectations can tune the responses of early visual regions to promote rapid identification of an expected percept (de Lange et al., 2018). A natural byproduct of this tuning is that other alternative interpretations of a visual stimulus are inhibited or less accessible (P4; Reynolds et al., 1999). If a system is tuned to process one type of input, this tuning is, in some sense, interfering with the processing of other inputs.

There is strong anatomical and neuroimaging evidence that sensory inputs from occipital cortex feed forward to various parts of gestalt cortex (Ungerleider & Mishkin, 1982). The evidence that nonsensory information (e.g., expectations) feeds back into gestalt cortex from other regions like the frontal lobe is less clear, though the anatomical connections that could support this do exist (Andersen et al., 1990; Clower et al., 2001; Uddin et al., 2010; Zhang & Li, 2014). Thus, there is little direct evidence bearing on

**Figure 9**
*Sensory and Nonsensory Influences on CEEing*



(A) Sensory Inputs
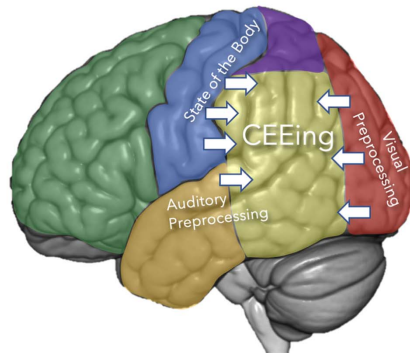
(B) Non-Sensory Constraints
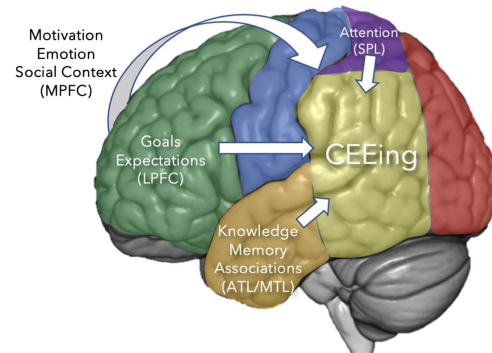
*Note.* Schematic of how CEEing is influenced by (a) various sensory representations provide strong inputs to CEEing and (b) expectations, goals, knowledge, memory, associations, attention, motivation, emotion, and social context can each tune and provide constraints on acts of CEEing. Neuroanatomical localizations are simplified and are presented here only for heuristic value. CEE = Coherent Effortless Experience. See the online article for the color version of this figure.

proposition 3.1 that gestalt cortex representations are influenced by nonsensory inputs to the extent that sensory inputs are ambiguous, absent, or incomplete (cf. Baldassano et al., 2016).

What is clear, at a psychological level, is that CEEing, distinct from visual preprocessing, is influenced by the activation of non-sensory representations including expectations, Bayesian priors, memories, associations, beliefs, stereotypes, schemas, and other bodily response representations when sensory inputs are ambiguous, absent, or incomplete (Bargh et al., 1988; Caruso et al., 2009; de Lange et al., 2018; Fazio et al., 2000; Frable & Bem, 1985; Freeman & Johnson, 2016, Hugenberg & Bodenhausen, 2003; Kunda & Sherman-Williams, 1993; Proffitt et al., 2003; Salomon et al., 2013; Stokes et al., 2012; Wood et al., 2016; Yuille & Kersten, 2006).[5] These representations can be activated by current goals, motivations, emotions, beliefs, and contextual cues (Anderson et al., 2011; Balcetis & Dunning, 2006; Barrett & Bar, 2009; Caruso et al., 2009; Fein et al., 2007; Leong et al., 2019; Levari et al., 2018; Phelps et al., 2006; Pitts et al., 2014; Sacco et al., 2011; Trope, 1986; Van de Cruys et al., 2013; Voss et al., 2008), but they can also be chronically activated by culture and identity-related processes (Golubickis et al., 2020; Markus et al., 1985; Nisbett & Miyamoto, 2005; Xiao et al., 2016).

It should be noted while this view suggests that CEEing is a constructive process influenced by nonsensory inputs, this does not imply that we can choose to CEE what we want (Firestone & Scholl, 2016). Rather, sensory and nonsensory inputs are expected to influence constraint satisfaction processes in gestalt cortex, with unambiguous sensory inputs given significantly more weight in this process. However, at this point, the evidence is stronger for this occurring during CEEing than this occurring in gestalt cortex, specifically. Little research to date has addressed this within gestalt cortex (Baldassano et al., 2016).

**CEEing Different (P3.2)**

The most important consequence of sensory and nonsensory representations mutually constraining our CEEing is that when

two people are presented with identical sensory stimuli that are ambiguous or incomplete, their idiosyncratic nonsensory inputs should lead them to CEE differently from each another (*P3.1*). This is more likely to occur as we move from the physical world to the semantic and psychological worlds, where the sensory inputs are often far less constraining. It is in these domains that people are most likely to CEE differently from one another (Hastorf & Cantril, 1954; Kahan et al., 2012; Maner et al., 2005).

If CEEing leads to idiosyncratic construals (*P3*) and if CEEing is associated with gestalt cortex (*P1*), then the extent to which any two people are having more similar or different subjective construals should be reflected in gestalt cortex (*P3.2*). Numerous neuroimaging studies using a neural synchrony approach have examined *construal similarity*. Unlike the earlier neural synchrony studies that examined the temporal receptive fields of different brain regions, here studies are examining the correspondence between neural synchrony and shared subjective construals. These construal similarity studies fall into four categories.

First, in the unconstrained studies, participants see or listen to ambiguous narratives. Those who recall these stories more similarly, presumably because they construed the stories more similarly, consistently show greater neural synchrony in gestalt cortex region IPL across studies, with no other region appearing reliably (Burns et al., 2021; Nguyen et al., 2019; Saalasti et al., 2019). Next, in the mental set studies, participants are either asked to watch a movie from a particular perspective (detective vs. interior decorator) or varying contextual information induces these differing perspectives (Ames et al., 2015; Dieffenbach & Lieberman, 2022; Lahnakoski et al., 2014; Yeshurun et al., 2017). These studies typically show perspective-linked neural synchrony effects in gestalt cortex, such that those who share an induced perspective have greater IPL synchrony with one another than those who do not. These studies also typically show perspective-linked synchrony in dorsomedial

[5] There is active debate over whether low-level visual preprocessing in areas V1–V4 can be impacted by nonsensory representations (de Lange et al., 2018; Firestone & Scholl, 2016), but it is clear that such effects occur at the level of consciously experienced CEEing.

prefrontal cortex (DMPFC) and PMC, outside of gestalt cortex. A third category examines two people experiencing conflict. Presumably, when people are experiencing conflict, they are seeing things less similarly than when they are having an agreeable conversation. In the only study in this domain (Binnquist et al., 2022), we observed reduced neural synchrony in TPJ and DMPFC during high conflict conversations relative to agreeable conversations. Finally, a few studies have used groups with individual differences to examine different ways of seeing (Dieffenbach, 2021; Dieffenbach et al., 2021; Finn et al., 2018; Parkinson et al., 2018; Salmi et al., 2013; Leong et al., 2019; van Baar et al., 2021). In these studies, the group more likely to have a single coherent perspective on the story shows greater neural synchrony in gestalt cortex (i.e., IPL) and DMPFC than the other group. For instance, a story in which participants might or might not find events suspicious produces greater neural synchrony in IPL in those with high trait paranoia (Finn et al., 2018). It should be noted that PTC and VTC also showed relevant synchrony effects in multiple studies reviewed above (Lahnakoski et al., 2014; Nguyen, Vanderwal, & Hasson, 2019; Parkinson et al., 2018; Salmi et al., 2013).

The results of this section arguably provide the strongest evidence for the basic proposition that pre-reflective subjective construals are associated with gestalt cortex (P1). These results demonstrate that as construal similarity increases across individuals, their neural synchrony within gestalt cortex increases as well. No other region of the brain reliably shows evidence of tracking idiosyncratic subjective construals that result from identical sensory inputs. It is also interesting to note that while gestalt cortex appears in nearly all of the studies of construal similarity, DMPFC synchrony was most reliably present when participants are provided with a particular perspective to embody (Ames et al., 2015; Dieffenbach & Lieberman, 2022; Yeshurun et al., 2017) or have a strong preexisting viewpoint that is identity relevant (Dieffenbach, 2021; Leong et al., 2019; van Baar et al., 2021). In contrast, when people are casually experiencing things that are not linked to one's identity or an overt mental set, gestalt cortex appears to support subjective construals more than DMPFC.

In summary, there is substantial support for some aspects of proposition 3, but also gaps in the literature that leave other aspects unaddressed. There is abundant evidence that CEEing processes are influenced by both sensory and nonsensory processes and that the latter's influence grows when the former is ambiguous, absent, or incomplete (P3.1). However, such processes have not been examined in the context of gestalt cortex. There is also strong evidence that as construal similarity increases between two individuals, neural synchrony in gestalt cortex also increases (P3.2).

## Proposition 4: CEEing Leads to Inhibition of Alternative Construals (or Their Underlying Elements)

As indicated earlier, constraint satisfaction processes provide a good account of how coherent interpretations can effortlessly be generated from a collection of initially ambiguous and even conflicting local representations. One of the natural byproducts of constraint satisfaction is that non-winning construals are inhibited and if this actually occurs, this would help explain why pre-reflective construals promote naïve realism. Thus, proposition 4 suggests that acts of CEEing ought to lead to the inhibition of alternative construals or

the underlying elements that could be used to generate alternative construals. At this point, there is only a modest amount of evidence bearing on this hypothesis, but the studies that exist are suggestive.

First, in the visual domain, it appears that producing a consciously experienced integrative perception tends to inhibit alternative global percepts or inhibit the neural representation of the local elements in favor of global processing. This takes at least two forms. First, global perception activates gestalt cortex (Carther-Krone et al., 2020; Himmelbach et al., 2009; Huberle & Karnath, 2012), but global perception also suppresses activity in early visual areas (e.g., V1/V2) associated with the local aspects of perception (de-Wit et al., 2012; Grassi, Zaretskaya, & Bartels, 2017). Simple object or face perception, which depends on VTC activity in gestalt cortex, also reduces V1 activity (Chen et al., 2010; Fang, Kersten, & Murray, 2008; Murray, Kersten et al., 2002). Similarly, when cross-modal binding of an auditory and visual cue occurs multisensory perception, there is reduced activity in V1 and primary auditory cortex compared to when the cues are experienced as separate (Bushara et al., 2003). Thus, global form perception appears to reduce the activation of local element processing (see also Seymour et al., 2018).

The second form of suppression is observed in binocular rivalry studies in which images of different objects are projected to each eye, but only one of the two percepts is consciously experienced at each moment. Early visual regions like V1 continue to respond to the entire visual array regardless of which image is experienced, however, VTC regions in gestalt cortex, such as the FFA and parahippocampal place area (PPA), have activity that closely tracks subjective perception when shown a face and a house simultaneously (Logothetis, 1998; Tong et al., 1998). Critically, activity in FFA and PPA drops precipitously when its preferred object category is not consciously perceived even though early visual areas are still presumably feeding forward activity associated with both stimuli. Although the exact mechanism of this apparent alternating suppression of FFA and PPA is not known, it is consistent with competitive inhibition described above (McClelland & Rumelhart, 1981; Vosse & Kempen, 2000).

There are also multiple studies in the semantic domain that suggest that CEEing may lead to inhibition of alternative interpretations or construals of inputs. For instance, Lewis et al. (2019) examined neural responses to taxonomic and thematic semantic relationships. They observed that not only was gestalt cortex (i.e., TPJ/AG) more active in response to thematically related words, but also that its activity was linked to the inhibition of other competing associations.

Perhaps the strongest evidence linking conscious but effortless integrative processes to inhibition comes from the behavioral domain. The question asked in work by Marcel (1980) is whether words are only integrated together when consciously experienced (P1.5) and whether this conscious integration inhibits alternative meanings of the words (P4). Consider a lexical decision task targeting the final word in a three-word sequence "hand–palm–wrist." That is, the three words are presented one at a time in sequence and the participant must indicate as quickly as possible whether the third letter string ("wrist") is a real word. The lexical decision regarding "wrist" should be facilitated from the preceding semantic associates, as "hand" and "palm" should both make "wrist" more accessible.

Marcel (1980; see also Schvaneveldt et al., 1976) compared this type of "congruent" word string to "incongruent" word strings such as "tree–palm–wrist" (See Figure 10a). Here, "tree" and "wrist" are associated with distinct meanings of "palm." An important question is whether "palm" will still facilitate "wrist" if it has already been semantically integrated with "tree." Put another way, do "palm trees" facilitate "wrists"? The answer depends on whether the word "palm" is processed consciously or not.

Critically, the middle word ("palm") in this study was either presented masked or unmasked, such that masked presentations were not consciously seen but unmasked presentations were. The hypothesis was that the middle word would only be semantically integrated with the first word if they were both consciously seen. Masked and unmasked middle words of congruent strings both facilitated the lexical decision of the last word relative to control strings like "clock–race–wrist" (Figure 10b, blue bar in each group). However, masked and unmasked middle words of incongruent strings produced opposite effects (Figure 10b, orange bar in each group). When "palm" was masked after "tree," it still facilitated "wrist," relative to control, suggesting that when unconsciously processed, "palm" is not semantically constrained by or integrated with "tree," but instead activates all of its meanings simultaneously.

**Figure 10**
*Semantic Integration Is Conscious*
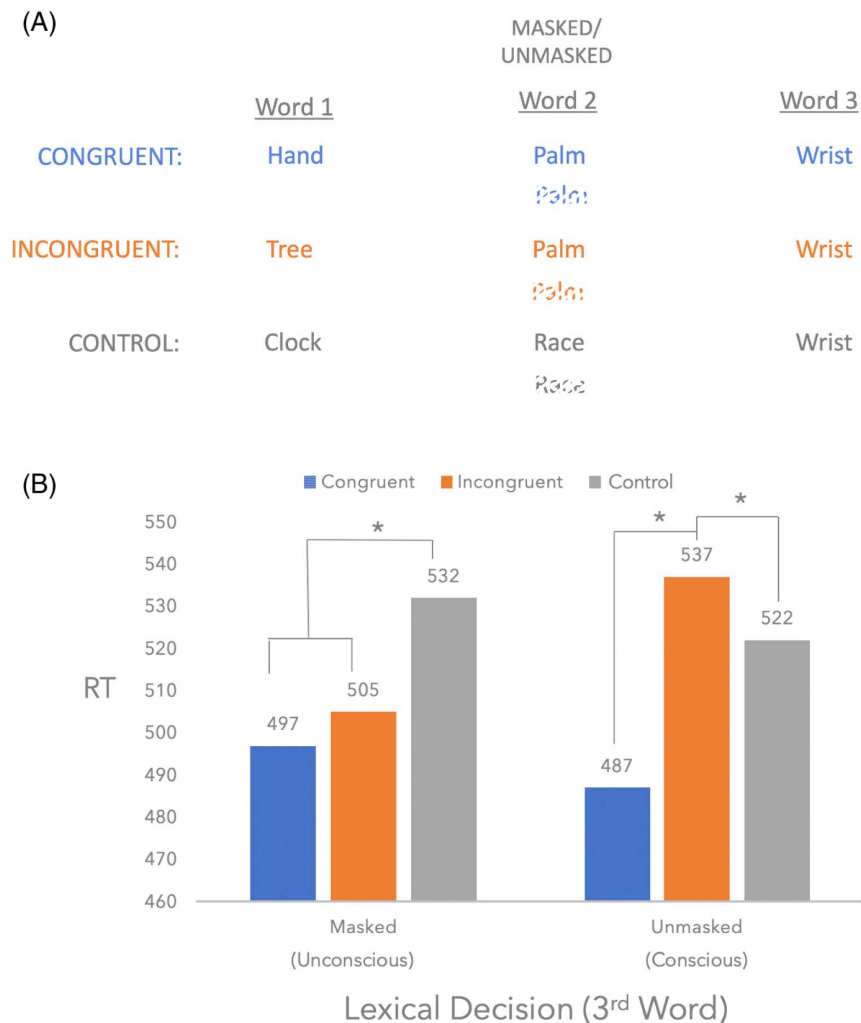


*Note.* Panel (A) Participants in Marcel (1980) were shown three-word sequences like "hand–palm—wrist" (congruent) and "tree—palm—wrist" (incongruent) and performed a lexical decision task on the third word. Congruency is determined by whether the same meaning of the second word relates it to both the first and third words. The second word was masked or unmasked. (B) If the second word is masked and thus outside of conscious awareness, no semantic integration occurs between first and second word (left bar group). If the second word is unmasked and consciously perceived, semantic integration between the first and second words does occur and can inhibit alternate meanings of the second word when the integrated meaning conflicts with the final target word (right bar group). See the online article for the color version of this figure.

In contrast, when "palm" was unmasked after "tree," and thus consciously seen, it inhibited the lexical decision for "wrist" relative to control and congruent trials.

This result suggests that "palm" is only semantically integrated with and constrained by "tree" when it is consciously processed (*P1.5*) and that when this occurs, other alternative meanings of the word "palm" are inhibited (*P4*), slowing down responses to "wrist." Also note that the timing in this paradigm likely allowed time for conscious seeing of the middle word (when unmasked) but not much time for conscious thinking, suggesting that the semantic integration here is a function of CEEing rather than thinking.

Greenwald and Liu (1985) reported a similar failure of semantic integration during subliminal presentation of two-word phrases like "enemy loses" in an evaluative priming task. Although Sklar et al. (2012) reported unconscious semantic processing of entire sentences, Rabagliati et al. (2018) were unable to reproduce this effect in a series of higher powered replications. An fMRI study by Graves et al. (2010) found an analogous result to Greenwald and Liu in an fMRI study. Explicit semantic integration of phrases like "lake house" was associated with AG activity, relative to phrases like "house lake." When the integration would have to occur implicitly, AG no longer differentiated these phrases suggesting AG plays a role in semantic integration and that this only occurs for consciously experienced words (*P1.5*). Similar results were observed by Yang et al. (2017) in an EEG study (c.f. van Gaal et al., 2014).

Together, the results in this section suggest that in the visual and semantic domains, consciously experienced coherence is associated with inhibitory consequences either for alternative interpretations of the stimuli or for the local representations that could be used to generate alternative interpretations (*P4*). That said, given the paucity of work in this area, more research bearing on the proposition is needed. In particular, there are no neuroimaging studies examining whether psychological CEEing produces similar inhibitory effects as visual and semantic CEEing do.

## Summarizing the Neural Evidence

The extent to which the neural evidence supports the propositions of the CEEing model is presented in Table 4 (see also Figure 11). The evidence is moderate to strongly supportive of most of these

claims, with more research needed for a few others. Gestalt cortex is broadly associated with conscious processes (*P1.1*), is not involved with conscious thought (*P1.2*) once the most dorsal portion of IPL is excluded, and with the possible exception of FFA is not involved in purely non-conscious processes that are never integrated into conscious construals (*P1.3*). Various processes that feel effortless do activate gestalt cortex, whereas increases in effort and cognitive load are associated with activity in prefrontal and dorsal parietal regions outside of gestalt cortex (*P1.4*). Processes that generate conscious coherence are reliably associated with gestalt cortex (*P1.5*) along with occipital cortex and IPS. Together, this evidence supports the general claim (*P1*) that coherent effortless experiential processes are associated with gestalt cortex. There is also strong evidence that CEEing occurs in gestalt cortex across visual, semantic, and psychological domains (*P2*). Additionally, while there is no direct evidence regarding the integration of sensory and nonsensory information in gestalt cortex (*P3.1*), there is substantial evidence that CEEing is sensitive to both sensory and nonsensory inputs and that construal similarity across people is best tracked by neural synchrony in gestalt cortex (*P3.2*). Finally, there is some evidence that generating coherent integrations across multiple elements leads to inhibition of the underlying elements or alternative interpretations (*P4*). These inhibitory effects have been seen in both VTC and IPL, but not in PTC. Overall, these results represent a significant degree of initial support for the four propositions of the CEEing model of pre-reflective subjective construals.

There are at least two limitations of this data with respect to the CEEing model. First, not all subregions of the gestalt cortex show consistent evidence across all of the propositions (Table 4). When excluding the most dorsal aspect of IPL, the remaining part of IPL, including TPJ, shows moderate to strong evidence for each proposition aside from proposition 3.1 which is untested. In contrast, data from PTC, excluding TPJ, and VTC show support for most, but not all, of the propositions. These regions both show evidence associated with coherent effortless experience, but neither appears to do so in the context of semantic or narrative domains. This suggests while IPL may support transmodal CEEing, PTC and VTC may show more modality-specific forms of CEEing.

The second limitation is that there are regions outside of gestalt cortex which also show some effects associated with CEEing.

**Table 4**
*Summary of Evidence Related to CEEing and Gestalt Cortex*

| Topic | Proposition | Overall support | IPL | PTC | VTC |
|---|---|---|---|---|---|
| Consciousness | 1.1 | Strong | + | + | + |
| Not conscious thought | 1.2 | Strong | + | + | + |
| Not purely non-conscious | 1.3 | Strong | + | + | +/− |
| Effortlessness | 1.4 | Strong | + | + | + |
| Coherence | 1.5 | Strong | + | + | + |
| Visual CEEing | 2 | Strong | + | + | + |
| Semantic CEEing | 2 | Strong | + | − | − |
| Psychological CEEing | 2 | Strong | + | + | + |
| Narrative CEEing | 2 | Strong | + | − | − |
| Sensory & nonsensory inputs | 3.1 | Untested | o | o | o |
| Construal similarity | 3.2 | Strong | + | + | + |
| Inhibition | 4 | Modest | + | − | + |

*Note.* See Table 1 for full description of propositions; IPL is inferior parietal lobule; PTC is lateral posterior temporal cortex; VTC is ventral temporal cortex. "+" = evidence for proposition, "−" = lack of evidence for proposition, "+/−" = evidence varies by subarea of region, "o" = open question or no direct evidence. CEE = Coherent Effortless Experience.

**Figure 11**
*Distribution of CEEing Throughout Gestalt Cortex*
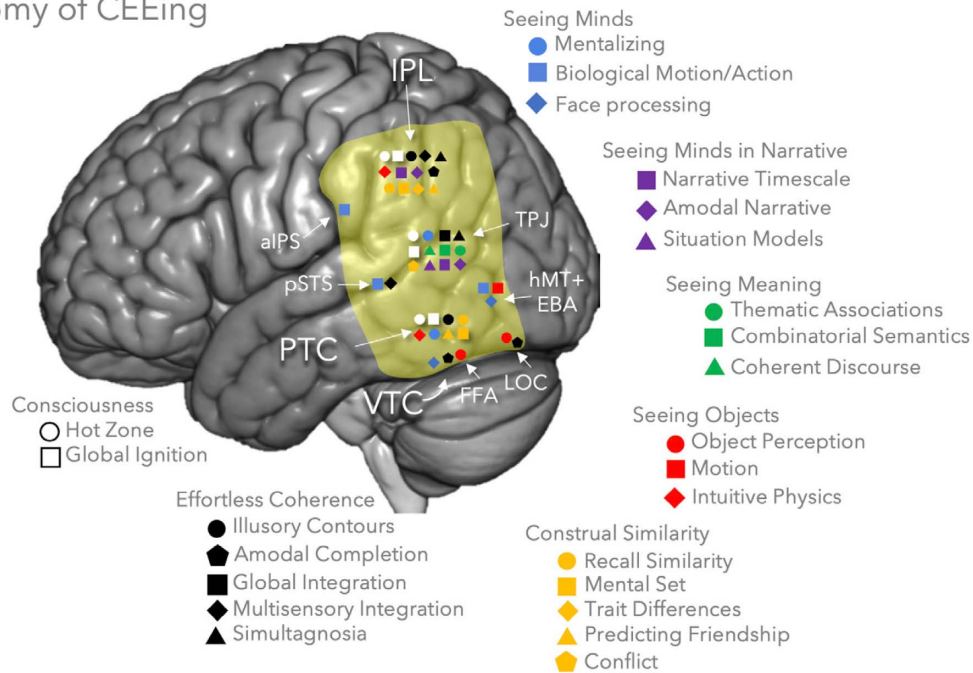


*Note.* Each color represents a category of psychological process, whereas the same shape across colors has no significance (e.g., there is nothing in common across the squares of different colors). Note that for most colors (e.g., black), the markers are distributed throughout gestalt cortex suggesting that gestalt cortex is broadly involved in most of these psychological categories. For the most part, markers are centrally placed in the region(s) they appear in. Object, motion, and action perception are given more precise anatomical locations. CEE = Coherent Effortless Experience. See the online article for the color version of this figure.

For instance, PMC appears in studies on conscious and effortless processing as well as in the narrative and construal similarity studies. While PMC appears in some but not most implicit mentalizing studies, it does not appear in most of the studies of visual CEEing. Given that the central precuneus within PMC has strong anatomical connections to IPL (Margulies et al., 2009), it is possible this region of PMC is functionally linked to other parts of gestalt cortex. Additionally, IPS appears in studies of coherence and studies in the domain of visual processing, narrative processing, and construal similarity, however, it is also reliably associated with conscious thought and effortful processing and thus is a weaker candidate for being a part of gestalt cortex.

Together this review provides substantial evidence that gestalt cortex plays a major role in supporting pre-reflective subjective construals that are conscious, effortless, and coherent. No prior theory has suggested that any region of the brain should have these processing characteristics, yet gestalt cortex meets these criteria across a broad range of relevant studies. The literature reviewed helps establish that these pre-reflective construals are localized to gestalt cortex regardless of whether they are visual, semantic, or psychological in nature. In other words, irrespective of what type of CEEing a person is doing, they are likely to be using gestalt cortex to accomplish this. While other regions, such as PMC and DMPFC, likely contribute to CEEing under some circumstances, gestalt cortex, particularly in IPL/TPJ, appears to be central to nearly all

instances of CEEing. The remainder of this review focuses on why the inherent characteristics of pre-reflective construals would give rise to naïve realism and the implications of the CEEing model for other research.

## Why Pre-Reflective Construals Produce Naïve Realism

Naïve realism may be the single most underappreciated source of conflict and distrust across individuals and groups (Ross, 2018). As described above, naïve realism is the conviction that one sees reality objectively, exactly as it is (Ross & Ward, 1996). In other words, we fail to appreciate all of the idiosyncratic constructive processes (i.e., subjective construals) that give rise to how we see the world and fail to appreciate that others have their own idiosyncratic constructive processes that can give rise to different ways of seeing the world. As a result, when others see the world differently than we do, it can serve as an existential threat to our own contact with reality and often leads to anger and suspicion about the others.

Why would the features of pre-reflective construals produce such strong convictions that we are transparently seeing reality as it is? Why is our immediate experience not more tentative, coming through as an initial hypothesis about what is going on around us, instead of feeling like the last word on the subject? In other words, what about the nature of pre-reflective construal turns us into

naïve realists? Below four non-mutually exclusive accounts are provided (see Table 5).

## Self-Authorship

Naïve realism has been described as resulting from a failure to engage in perspective-taking and it is true that a willingness to appreciate another's perspective would be helpful in overcoming naïve realism (Ross & Ward, 1996). Less has been said about what features of subjective construal make it the sort of thing where we are resistant to perspective-taking. Here, the assumption might be that the other side does not deserve our perspective-taking efforts; clearly, they are not trying to appreciate our perspective so why should we try to appreciate theirs. But there are also structural features of subjective construal that prevent us from even considering the possibility of taking another's perspective.

Consider a situation where we are open to the possibility that others might reasonably make sense of things differently than we do. Imagine an analyst has conducted an assessment of next year's market for Honeycrisp apples. The analyst's partner might point out an error in the analyst's calculations or the logic applied to pull the information together. We can imagine in this situation that the analyst might be open to these alternative perspectives and adjust her own assessment. Now consider that the same analyst is about to take a drink of water from a glass sitting in front of her when the partner points at the glass and says, "When did you get a trombone?" The analyst would reject this comment as either a joke or an indicator that her partner needs to see a neurologist. No one would characterize this rejection as a failure of perspective-taking. Few would suggest that if only the analyst had thought harder and engaged in perspective-taking, she would appreciate her partner's way of seeing.

How do these situations differ? The assessment of the market for Honeycrisp apples is a reflective construal that results from effortful conscious thought, whereas the second situation focuses on a pre-reflective construal involving an effortless act of perception. With conscious thought, there are a series of mental steps that can be recapitulated and reexamined for errors ("Oh, now I see the math error I made there"). With perception, there is no awareness that any mental steps have occurred, thus making it difficult to consider if any of these steps were a wrong turn. Effort and time may serve as important metacognitive cues distinguishing these acts. Thinking is not only effortful, but our awareness of this effort and the time associated with thinking, may serve as cues that our acts of thinking are authored by us (Demanet et al., 2013; Lieberman et al., 2002; Wegner & Wheatley, 1999). When we do long division, the effort and time

involved may promote our sense of having intentionally performed that act. In contrast, the vast majority of perceptual acts feel effortless and instantaneous. These acts do not feel authored by us but rather are experienced as merely "witnessing reality out there." In other words, perceptual acts may simply lack the metacognitive tags for processing time and effort that could render a perception something that others ought to be able to have a different perspective on.

The apple and trombone examples represent extreme ends of the thought-perception continuum. An example that might be of more real-world interest is when we hear a political speech. Two people with different ideological viewpoints will effortlessly construct different construals of what has been said and what it implies. Here, each person appears unreasonable when they are unwilling to consider the other's perspective as valid. However, if seeing a glass of water and seeing what a politician means are both acts of CEEing, then in both cases it may not be a failure of perspective taking that is most central to the dismissal of other perspectives. Rather acts of CEEing simply may not be experienced as self-authored and thus promote naïve realism. Here, the effortlessness and speed with which the speech is sized up may imply that one is seeing the truth in the world, rather than constructing a conclusion internally. It is true that perspective taking will not occur in this case, but the key contributor would be the missing metacognitive cues for self-authorship, rather than a willful refusal to engage in perspective taking. Our thinking is the kind of thing we believe can be questioned, but our seeing is not, and often our understanding is more like seeing than thinking.

Together with the neural evidence linking psychological CEEing with TPJ and psychological thinking with prefrontal regions like DMPFC, this presents a novel prediction. In tasks where psychological CEEing or psychological thinking could predominate how a task is performed, the absence of the latter, as indicated by less DMPFC activity, would be associated with a heightened tendency for naïve realism as indicated by greater confidence in one's judgments or less willingness to reconsider one's judgment in light of differing views.

Note that this account is largely in line with what has been presented previously by Ross (2018) regarding a failure of perspective-taking. The current account merely adds more meat to the bone as to the structural features of subjective construal, rather than the motivational features of interpersonal conflict, that might lead to a failure of perspective-taking. Additionally, this account suggests which mental acts will and will not feel open to reinterpretation by others. Those that come with metacognitive cues of effort and authorship should encourage perspective-taking more than those that lack these cues.

**Table 5**
*Why Pre-Reflective Subjective Construal Promotes Naïve Realism*

| Account | Explanation |
| --- | --- |
| Self-authorship | Subjective construals lack metacognitive tags (e.g., exerted effort, time on task) to indicate they are internally constructed rather than an objective picture of reality. Only understandings tagged as self-authored are considered open to alternative points of view. |
| Coherence substitution | Subjective construals are generated using a principle of coherence, but coherence is then used as a proxy for objective truth rather than actually reflecting objective truth. |
| Visibility of alternatives | Hill/valley structure of a constraint satisfaction network constrains the ability to see and represent alternative construals once the network has entered a valley (i.e., local minimum). |
| Winner takes all | Constraint satisfaction processes produce a construal by strengthening the representation of the elements that together are most coherent, while simultaneously weakening the representation of elements that support alternative interpretations. |

## Coherence Substitution

A second related reason for naïve realism is that pre-reflective construals may provide what feels like truth even though the primary driver of their output is coherence. Constraint satisfaction processes seek out low tension states that maximize coherence among the components, but it has no method for seeking out or evaluating truth (Simon, 2004)—propositional logic is required for the evaluation of truth.

Why would evolution promote coherence as a substitute for truth? Across most species and across most situations, coherence generated from constraint satisfaction processes represents a very efficient path toward modeling something that approximates but does not guarantee truth. Particularly in visual perception, the most coherent solution, the one that satisfies the most constraints, typically represents the correct categorization. Thus, this might serve as a proto-truth estimate in lots of species that have no propositional representation of truth and for humans it might serve as an adaptive substitute in many situations. It is when we move away from the visual to the semantic and psychological where coherence and truth are more likely to diverge, especially as more nonsensory inputs are influencing the constraint satisfaction process. However, the same neurocognitive apparatus in gestalt cortex evolved for visual CEEing might be called on to service these other domains efficiently, albeit at a lower level of accuracy.

Also, to be clear, it is not as if constraint satisfaction processes generate a high coherence construal and then we explicitly decide that it must represent the true state of affairs due to this level of coherence. Rather, when coherence is reached through constraint satisfaction, the question of truth may never arise for us. We act as if we believe the outputs without ever considering them—akin to what philosophers call an *alief* (Gendler, 2008; see also Gilbert, 1991).

## Visibility of Alternatives

The third potential reason that the characteristics of CEEing promote naïve realism is that constraint satisfaction operates on the hill/valley structure of different potential network states (see Figure 3). If we anthropomorphize the current state of the network, when in a valley (i.e., a local minimum) alternative interpretations (i.e., other valleys) that others might hold, "look" unreasonable because they are literally out of "visible" range as they are hidden on the other side of peaks and it would initially require an increase in network tension and a decrease in coherence to reach them. Put a different way, the other states that are visible in the network from one's current state may constitute one's "latitude of acceptance," the set of positions that a person could hold and still seem reasonable. Continuing to anthropomorphize, we could say that constraint satisfaction networks are teleologically averse to increasing tension in the network and so any moves that require such increases are "seen" in a negative light. This also speaks to potential ways to make people better able to appreciate other perspectives—either by maintaining a current state that is high up in the network with a better "view" or by changing the structure of the network itself such that the local minima are less deep and require less work to exit them (see Parker Singleton et al., 2021 for discussion of how psychedelics may accomplish this).

## Winner Takes All

Implicit in most accounts of naïve realism is the notion that it occurs as a direct result of inputs to construal processes being non-conscious. This renders our own contributions to what we see invisible to us and thus we mistake our construals as objective representations of reality that are not up for debate. Essentially, because we cannot see the special effects crew working in our mind, we believe we have merely witnessed things as they are. The self-authorship account above is a variation on this theme.

The fourth account of naïve realism focuses instead on how the process of generating coherent conscious construals directly alters the accessibility of *other* potential construals. Critically, this explanation is not about our lack of insight into the process, but rather that the underlying dynamics of the constraint satisfaction process make it more difficult to consider other perspectives. In this account, the act of CEEing typically functions by selecting one construal at the expense of all the others (Block, 2018). Iterative constraint satisfaction processes operate by boosting one set of activations that together form a coherent global interpretation, while simultaneously diminishing the activations that would support alternative interpretations of the data. One interpretation is enhanced, while others are inhibited and become less accessible (*P4*). This contrast function biases us to see the interpretation we have landed on as more preordained than it was at the beginning of the constraint satisfaction process because reasonable alternatives have disappeared.

We could have been built with a system that generates a leading construal hypothesis but continues to maintain alternative construals that can be reevaluated in light of future evidence, but this is not how constraint satisfaction and CEEing works. Second guessing is the province of thought, not seeing. The constraint satisfaction processes supporting pre-reflective construals are inherently a "winner take all" phenomenon, where local minima attractor states become self-reinforcing. Meanwhile, inhibitory processes appear to ensure the "losing" interpretations do not hang around by reducing their activation and thus their ability to influence the state of the network. The winning interpretation ends up looking far more inevitable than it ought to because when constraint satisfaction finishes, the winner looks like the only game in town (Block, 2018). As a result, we often mistake situations with substantial ambiguity (e.g., figuring out another person's motives for morally questionable behavior), for being more like situations with no ambiguity (e.g., the water-trombone example). Experienced ambiguity may drive actual perspective-taking and appreciation of alternative perspectives, but constraint satisfaction is designed to minimize experienced ambiguity. In other words, naïve realism occurs not because we fail to engage in perspective-taking, but rather because constraint satisfaction biases us against detecting the need to.

Imagine a parallel example involving going to the supermarket for food. If Jim always does the shopping and did not go to the supermarket this week, we would initially say the reason Jim and Pam have no food in the pantry is because Jim failed to go to the supermarket. What if Pam is responsible for telling Jim that they are out of food and it is time to go to the supermarket, but never hit send on the text message telling him to go? It is still true that Jim did not go to the supermarket, but we would say the more proximate cause is the text message that was not sent. In the case of naïve realism, perspective-taking may be the final step in overcoming naïve realism, but the more proximate causes may be the coherence-inducing and inhibitory consequences of constraint satisfaction.

Why would we be built this way—to generate a construal by inhibiting alternative ones? One theory (Morsella, 2005) is that consciousness is designed to facilitate efficient action plans or as

William James (1890/1950) put it, "My thinking is first and last and always for the sake of my doing" (Fiske, 1992). When one encounters an unfamiliar animal, one can approach or avoid it, but not both. Thus, the mind accentuates its best answer and discards the rival solutions. While such a process may be helpful in avoiding decisional paralysis at the moment, it leads to all sorts of problems when people compare notes and find that their CEEing yielded different solutions (Ross & Ward, 1996).

If this "winner takes all" account of naïve realism is correct, it suggests the process of generating a pre-reflective construal will inhibit the activation of other reasonable construals making them more difficult to access. One can imagine conducting a study like Marcel (1980) except instead of examining polysemous words, the same presented image would be amenable to more than one psychological construal. For instance, if given the word–picture–word sequence of "practice"—(image of someone playing guitar)—"rehearse," we would assume the picture would facilitate a lexical decision regarding the final word. However, if the first word was instead "procrastinating," one can imagine a different coherent interpretation of the picture which might suppress access to the rehearsing interpretation of the picture and inhibit the lexical decision response. Although the inhibitory effects of CEEing have been observed in the visual and semantic domains, this has not yet been examined in the psychological domain where it might be most important.

## CEEing: Other Implications and Connections

The primary goal of this review has been to present a neural and psychological model of pre-reflective subjective construal and to use this characterization to understand why humans fall prey to naïve realism. Nevertheless, the CEEing model has implications for several other ideas within psychology. Some of these are discussed below.

### Dual-Process Models

The CEEing model consists of four neurocognitive propositions (Table 1), each of which links psychological processes to gestalt cortex. The psychological processes linked to gestalt cortex are coherence, effortlessness, experience, and inhibition of alternatives. One of these features, effortlessness, appears in numerous dual-process models in social and cognitive psychology (Evans & Stanovich, 2013; Kahneman, 2011; Sherman et al., 2014). Along with the brief discussion of reflective and pre-reflective construals, one might naturally wonder whether the CEEing model represents one half of a dual-process model and if so, how it relates to existing models.

The CEEing model is decidedly not a dual-process model. The reflective versus pre-reflective distinction was introduced here only to then limit the scope of the rest of this review to pre-reflective construals. Effortless pre-reflective processing sounds more like a System 1 than a System 2 kind of process (Evans & Stanovich, 2013), so one might start there if one wanted to draw parallels. Yet most of the other features of the CEEing model do not fit neatly into either "system." To my knowledge, coherence and inhibition of alternatives is not part of any dual-process architecture. The closest might be the integration of information discussed in attribution and social cognition models (Gilbert et al., 1988; Smith & DeCoster, 2000), but in

these proposals integration is a System 2 process and refers to something other than the coherence that emerges from constraint satisfaction. Similarly, there is work suggesting that reflecting on one's emotional state can inhibit the neural correlates of that state (Torre & Lieberman, 2018), thus linking inhibition with System 2. This again is different than the kind of inhibition described here that emerges spontaneously from constraint satisfaction processes. Finally, while it was hypothesized that the processes contributing to pre-reflective construals might be non-conscious, these construals are predicted to occur in sequence, one at a time. Given that CEEing does not fit neatly into one system or the other, it seems unwise at this point to try to shoehorn it into either. If anything, System 1.5 might be a better label.

### Cognitive Diversity

There is clear evidence that having team members with different perspectives and experiences can enhance team performance, particularly in idea generation and creativity contexts (Phillips, 2014). To date, it has been difficult to assess what constitutes cognitive diversity, with demographic diversity (e.g., gender and race) often serving as a stand-in. Businesses claim to want people who "think different," but in the eponymous Apple ad, the narration actually starts by celebrating "the ones who see things differently." If CEEing differently is a form of cognitive diversity, with one's distinctive history of experiences shaping the dispositional ways a person's nonsensory processes influence the construal process, then this provides a potential path to measurement.

To be clear, neural synchrony techniques cannot easily tell us how each person is idiosyncratically CEEing the world. But neural synchrony can serve as an indicator of the extent to which two or more people are CEEing things in similar or different ways (Nguyen et al., 2019). Experiments could thus examine how different team compositions, based on neural synchrony during a preliminary task, lead to better or worse team performance as a function of task type. To be clear, in this context, organizations would likely be looking for teams that show less neural synchrony as an indicator of greater cognitive diversity.

### Compatibility

Despite online dating behemoth eHarmony's claim to rely on the "science of compatibility," scientists point out that "compatibility elements of human mating are challenging to predict before two people meet" (Joel et al., 2017). Science has identified characteristics that will make individuals generally more appealing to potential partners, but even sophisticated machine learning algorithms have been unable to predict compatibility between two specific people above and beyond these generic effects. Given the scrutiny eHarmony's claims received (Finkel & Karney, 2012; Finkel et al., 2012), it is little surprise that they have since changed their tagline.

A significant portion of romantic compatibility is undoubtedly cocreated over time in the relationship itself (Eastwick et al., 2021). The elements of compatibility that exist prior to this are probably a joint product of attraction and shared ways of experiencing the world. If two people CEE things more similarly, one would expect this to engender a sense of safety, trust, and shared reality (Hardin & Higgins, 1996). An fMRI study by Parkinson et al. (2018) supports this idea. In this study, members of a bounded community watched a

variety of videos one might find on the internet, each 1–4 min long. The authors examined whether neural synchrony across participants predicted real-life friendship and social distance. Neural synchrony in regions throughout gestalt cortex, but especially in IPL, were among the strongest predictors of friendship across all brain regions, after controlling for demographic variables. In other words, people who watch videos and tend to CEE them similarly, tend to be friends in real life. Critically, CEEing similarly at Time 1 predicts friendship at Time 2, controlling for friendship at Time 1 (C. Parkinson, *personal communication*) suggesting that CEEing actually drives the formation of social bonds.

### Lenses for CEEing

The idea of psychological lenses is an old concept (Epley, 2015; Frable & Bem, 1985; Higgins & King, 1981; Kelly, 1963) which implies that we have filters that shape what information is attended to and most easily assimilated into our current experience. In the context of the CEEing model, a lens is a summary description of the influence that our nonsensory constraints have on the way we CEE things. Sometimes these lenses are worn in a temporary fashion, depending on the situation or one's motivation, but others may be more enduring and dispositional. When groups or dyads show shared ways of CEEing that differ from other groups or dyads, this suggests that different lenses are being employed.

For both cognitive diversity and compatibility, how similarly people CEE can be assessed to some degree with neural synchrony. But there are many ways in which people might CEE similarly or differently and this might be better captured by identifying the different lenses that each person tends to use. Some people might have a lens that focuses them on the status of people in situations and how status shapes the interaction, while for others who lack this lens, status cues may be relatively invisible. Lenses are like the previously discussed HUDs that overlay a value for some characteristic on objects and events seen in the environment, except the value is experienced effortlessly as part of some entity or situation, just as color is experienced effortlessly as part of a physical object. Thus, the lenses that are active determine which aspects of a situation or a person's behavior will be highlighted and central to one's subjective construals. One can see through a lens of empathy, which will highlight the emotional states of others, or through a lens of orderliness, which will highlight the alignment and spacing of objects. Having an eye for costs, threats, or fairness are just a few of the myriad lenses through which people might see the world. We typically understand people in terms of how they psychologically react, feel, and behave. One could argue that each of these follows from how the person sees, and thus construes, the world. Measuring dispositional lenses in addition to traditional individual differences might capture important additional variance in outcomes of interest.

How might these different lenses be measured? It is possible that a self-report measure could capture this to some extent, depending on the degree to which people have insight into the extent to which certain aspects of situations tend to pop out for them. Although people may have difficulty describing the lenses being used right now at the moment, they may have some awareness of the lenses they use most often. One could also apply a *neural reference group* approach (Dieffenbach et al., 2021; Dieffenbach & Lieberman, 2022) to

examine a single lens. This would involve identifying groups of people likely to have or not have a particular lens. These groups could then be shown videos that are ambiguous with respect to that lens providing reference group profiles of what synchrony looks like in groups known to have or not have the lens. The neural synchrony outputs would then be used to identify whether the lens is being used by new individuals. This would also then allow interesting investigations into how malleable different lenses are. Can a person choose to adopt a lens they do not use dispositionally? Can various interventions lead to greater or lesser use of particular lenses?

### Emotional CEEing

This review has focused on CEEing the physical, psychological, meaning, and narrative worlds. There is no reason to think this is the exhaustive list of forms of CEEing. Another likely form of CEEing is *emotional CEEing* (Thagard & Nerb, 2002). I have previously argued (Lieberman, 2019), along with Frijda (1986), that emotional experience is, in part, a form of seeing—that each emotion corresponds to a lens that guides how we see the world for a short time. Emotional CEEing was not included as a major division of CEEing here because there are almost no studies examining the neural correlates of emotional experience, relative to more implicit affective responses. However, one recent study (Taschereau-Dumouchel et al., 2019) examined this and found that whereas regions like the amygdala, insula, and ventromedial PFC tracked purely non-conscious affective responses, right IPL in gestalt cortex was one of a handful of regions that more closely tracked with subjectively experienced emotion (see also Horikawa et al., 2020; Lettieri et al., 2019; Mohammadi et al., 2020). As in the case of visual perception, it might be the case that some regions, like the amygdala, engage in *emotional preprocessing* that promotes emotional CEEing within gestalt cortex.

### Differentiating DMPFC and TPJ

Activations in DMPFC and TPJ co-occur in most mentalizing and default mode network studies. This has made it difficult to tease apart the functionality of these two regions. Across the literature considered here, there are at least some hints as to the differential functionality of DMPFC and TPJ. First, while TPJ appears in both explicit and implicit ToM studies, DMPFC is much more likely to appear in explicit than implicit ToM studies. Second, in the neural synchrony studies of construal similarity, DMPFC effects selectively occurred only when participants were explicitly given a mindset to use while watching a video or when the individuals had strong dispositions relevant to the video or interaction. When participants were just casually watching a video with no strong relevant predisposition, IPL/TPJ showed reliably synchrony effects, but DMPFC did not. These results are generally consistent with the idea that DMPFC is more involved in psychological thinking than psychological CEEing. Taking on a particular psychological mindset or watching videos with strong predispositions may be more likely to invoke engage explicit psychological thinking than casual psychological CEEing.

Although cognitive load is commonly used by cognitive and social psychologists to distinguish automatic and controlled processes (Gilbert et al., 1988; Greene et al., 2008), it is rarely used for

this purpose in fMRI studies (Rameson et al., 2012; Spunt & Lieberman, 2013).[6] While there may be some difficulties in interpreting cognitive load results in typical fMRI studies, the use of cognitive load in the context of neural synchrony approaches may be quite fruitful. In typical fMRI studies, cognitive load may introduce task-irrelevant activity in the same brain regions that would otherwise produce effortful task-relevant activity, however, synchrony will likely only be caused by task-relevant activity as long as cognitive load processes are not time-locked across participants.

If TPJ and DMPFC support psychological CEEing and thinking, respectively, cognitive load ought to reduce DMPFC synchrony much more than TPJ synchrony as cognitive load should derail psychological thinking more easily than psychological CEEing. Also, if a temporary perspective has been induced (e.g., viewing a video interview in terms of a person's fit for a job or in terms of that person's mental health; Langer & Abelson, 1974), cognitive load should reduce the extent to which both TPJ and MPFC synchrony is greater within perspective than across perspectives. However, if individuals with longstanding differences in perspective (e.g., political partisans) watch a video under cognitive load, TPJ ought to still produce greater within perspective synchrony than across perspectives. In the first instance (i.e., job fit vs. mental health), psychological thinking is required to maintain the mental set, but in the second case (i.e., political partisans) it is not.

## Conclusion

This review has presented a model of how people see the world, not merely in a visual sense, but in the broader sense that focuses on pre-reflective construals—conscious, effortless, coherent understandings. Based on the convergent neural data, the evidence is clear that gestalt cortex is central to these pre-reflective construals. Specifically, mental acts that are coherent, effortless, and experiential tend to occur in gestalt cortex; activity in gestalt cortex tracks construal similarity across individuals; and such activity can lead to the inhibition of alternative construals. Together, the inherent characteristics of these pre-reflective construals help explain why they naturally lead us to have irrational confidence in our own experiences of the world and to see others as biased, misinformed, or worse when they fail to see the world the way we do.

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[6] Cognitive load manipulations are probably the best current way to differentiate CEEing from thinking. The conscious construals participants generate under cognitive load are likely to reflect CEEing. However, in daily life CEEing occurs regularly without the introduction of cognitive load. It is also possible that differential neural synchrony in gestalt cortex and other frontoparietal areas may eventually serve as an indicator as well.

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