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Facing Ambiguity: What We Do in the Space Between Stimulus and Response

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Abstract

An extensive body of research on human and nonhuman animals has examined responses to clear valence, including stimuli that either represent a relatively clear threat (e.g., electric shock) or a clear reward (e.g., money). But daily life is replete with events or situations that are ambiguous—they could be threatening and/or rewarding. This article describes work that examines the wide interindividual variability with which humans respond to this dual-valence ambiguity. Although some individuals more readily categorize these events as negative, others are prone to arrive at more positive categorizations. This predilection to lean in a more negative versus positive direction represents a stable, trait-like difference and is referred to as "valence bias." Valence bias is generalizable across categories of dual-valence ambiguity and has important implications for health and well-being. Here I focus on extensive findings that lend support for the initial negativity hypothesis, which posits that the initial or default response is negative across people and that positivity relies on an additional regulatory mechanism that helps to overcome the initial negativity. I also describe the cognitive and brain mechanisms underlying the valence bias, including emphasizing the importance of a broad set of systems that support human responses to ambiguity.

Keywords

emotional ambiguity, valence bias, individual differences, interpretation bias, reappraisal

> Between stimulus and response there is a space. In that space is our power to choose our response. In our response lies our growth and our freedom.
>
> —Viktor E. Frankl

Considerable work in various domains of psychology, including clinical psychology and psychiatry, has usefully sought to characterize responses to stimuli whose valence is relatively clear. For example, work has examined how individuals respond to looming threats and, in clinical work, compared these responses to those of individuals with panic disorder. Neuroimaging studies have historically focused on measuring brain responses to images depicting clear threats (e.g., scenes of car accidents or bruised and bloody bodies; Varkevisser et al., 2024). But everyday life is replete with situations in which valence is ambiguous. How do individuals respond to these situations? And why do some individuals appear to process these situations as largely negative whereas others process them as more positive?

Ambiguity abounds in daily life, forcing people to make decisions in contexts in which information is incomplete—be they financial (e.g., "Will this be worth the expense?"), medical (e.g., "Are these symptoms benign?"), or interpersonal (e.g., "Is that person laughing at me or something else?"). Work done in the last decade (Hirsch et al., 2016; Neta, 2024; Neta et al., 2009; for a review, see Vos et al., 2025) has focused on examining individual differences in response to stimuli that are ambiguous, meaning that they have multiple possible valence interpretations that are equally valid (i.e., positive or negative). Much of this work has examined responses to stimuli that could be interpreted as either threatening or *neutral*—for example, asking participants to evaluate a word like "hit," a homograph that can have both threatening (e.g., "attack") and benign (e.g., "song") meanings (Hirsch et al., 2016). Only relatively recently have we and others narrowed in on

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stimuli for which valid interpretations could be either negative or *positive* (Harp et al., 2021; Neta et al., 2009, 2013). For example, surprised facial expressions can signal both negative (e.g., witnessing a car accident) or positive (e.g., finding a $100 bill) outcomes. This important distinction in dual-valence ambiguity allows researchers to explore the tendency with which an individual leans toward a negative or positive interpretation when both are readily available—something termed "valence bias."

It is important to note here that this valence bias is somewhat different from the computations of ambiguity implicated in constructionism, one of the leading theories of emotion. Constructionism views emotions (e.g., joy, anger, fear) as concepts that people learn through socialization (Russell, 2003). As Russell noted, "the sequence of events that make up any actual emotional episode . . . is constructed anew each time to fit its specific circumstances" (p. 151). In short, constructionism is a model of the computation of emotional experience, in which every emotion is considered ambiguous to some extent because there is variability between—and even within—people in response to clear emotions such as fear and joy. In contrast, our definition of valence bias is focused on the computations that specifically drive ascriptions of valence (positive vs. negative) to stimuli that signal greater ambiguity. Because of prior learning and other factors, certain stimuli such as smiling faces are associated with positive valence, whereas others such as fearful faces are associated with negative valence by almost all participants almost all of the time. However, individuals' experiences with surprise are less clear-cut—the probability of surprise being negative versus positive is closer to 50%. For these stimuli, valence ascription is more equivocal, and individuals show clear differences in their propensity to ascribe negative versus positive meaning to such stimuli. Robust evidence for this comes from data showing that categorizations of emotional ambiguity (e.g., surprised faces) take longer than the same categorizations of relatively clear valence (e.g., angry and happy faces; Harp et al., 2021; Neta et al., 2013), which may represent a shift toward deeper processing associated with emotional ambiguity (Chang & Brainerd, 2021).

This article briefly describes findings demonstrating stable individual differences in how humans respond to dual-valence ambiguity, discusses the important implications that this valence bias has for health and well-being, and provides a brief overview of the mechanistic work that indicates an initial negativity bias. Neuroimaging evidence pointing to a broad set of systems that support human responses to ambiguity is also presented.

Valence Bias as a Lens

For more than a decade my colleagues and I have explored individual differences in categorizing dual-valence ambiguous stimuli as either negative or positive. We originally focused on asking participants to categorize surprised facial expressions as negative or positive (Neta et al., 2009) and then expanded this work to show that the same bias drives responses to dual-valence scenes (e.g., a scene of two people in a tearful embrace; Neta et al., 2013) and words (e.g., "BREAK"; Harp et al., 2021). In addition to this generalizability across categories, valence bias shows high test-retest reliability across a period of several weeks and even up to a year (Harp et al., 2022); that is, valence bias appears relatively stable. Together, this bias has come to be viewed as representing a "lens" through which an individual views the world.

Lessons From Development

Despite the stability in valence bias in young adults, other work has shown that there is a shift in valence bias across longer timescales (i.e., one's lifespan). For example, children show a more negative valence bias than do adolescents and adults (Petro et al., 2021; Tottenham et al., 2013). Further, valence bias becomes increasingly positive with increasing age in adulthood (ages 19–71; Neta & Tong, 2016), consistent with the positivity effect in aging (Carstensen & DeLiema, 2018). Taken together, there is evidence for a valence bias trajectory that shifts from a relatively negative bias to a relatively positive one across the lifespan, evidencing an initial negativity that is overcome with age.

The Initial Negativity Hypothesis

Extensive work has examined the underlying processes that produce these individual differences in bias. The working model here suggests that, despite the variability in valence bias between individuals, there is an *initial negativity* across people (i.e., everyone shows an initial or default negative response; Fig. 1a). Over the years, much evidence has been accumulated to support this initial negativity hypothesis (INH). For example, surprised faces "pop out" more in a context of happy than angry faces (Neta et al., 2011), suggesting they are more inherently negative in nature. Further, negative categorizations of dual-valence ambiguity are faster than positive categorizations (Neta et al., 2009; Pierce et al., 2023), and a simple instruction to delay responses produces more positive categorizations (Neta & Tong, 2016). This indirectly suggests that there is an extra processing step involved in arriving at a more positive rating.

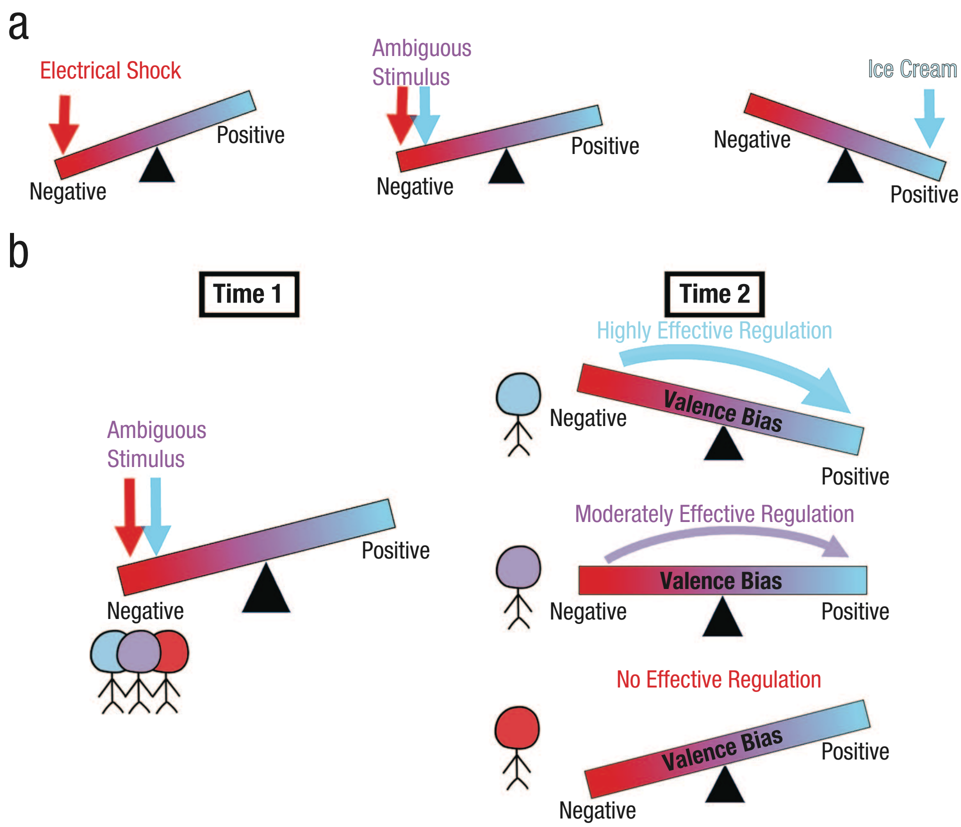

Fig. 1. Mechanistic account of valence bias. Affective responses are illustrated for stimuli that are (a, left) clearly negative and (a, right) clearly positive. Responses to (a, middle) ambiguous stimuli are characterized by an initial negativity regardless of whether someone ultimately shows a more negative valence bias (red arrow) or a more positive bias (blue arrow). Unpacking the response to ambiguity reveals (b) an initial negativity across individuals with different valence biases (Time 1; left). This initial negativity is updated with a more regulated (less negative) bias in some people (blue individual at the top right) or is maintained as a less regulated (more negative) bias in others (red individual at the bottom right; Time 2). This variability in valence bias, of course, lies on a continuum such that there are also individuals who might display moderate regulation and show a valence bias that is somewhere in the middle (purple individual at the center right). Adapted from Neta (2024) with permission from Guilford Press.

More direct evidence for the INH comes from mouse-tracking studies examining the trajectories of these responses that reveal the underlying mental processes associated with evaluating the response alternatives (Freeman & Ambady, 2010). To elaborate, several studies found that positive categorizations were characterized by an initial attraction to the competing (negative) response option but that negative categorizations were associated with more direct trajectories (Brown et al., 2017; Neta et al., 2021). In other words, the response trajectories revealed an initial movement toward the negative response option, even for trials that were ultimately categorized as positive.

Other work leveraging neural mechanisms of visual processing used filtered images of face stimuli to emphasize low spatial frequencies (LSFs), which receive priority processing in the brain, and compared the categorizations of those stimuli to others filtered to emphasize high spatial frequencies (HSFs), which are processed more slowly and deliberately. On the basis of the INH, LSFs of surprised faces were predicted to be categorized as more negative than the HSFs, indicating that the faster response is biased negatively—and these predictions were borne out in empirical work (Neta & Whalen, 2010; Neta et al., 2021).

These data supporting the INH suggest that individuals who show a more positive valence bias are likely regulating or overcoming this default negativity via a (slower) regulatory process (Neta, 2024; Fig. 1b). Indeed, evidence demonstrates that cognitive reappraisal may be a mechanism that supports a more positive valence bias, enabling individuals to reinterpret the initially negative stimulus as having a positive interpretation (Neta, 2024; for work showing that attention deployment may also shape one's bias, however, see Neta & Dodd, 2018). Neuroimaging supports this claim—individuals with a more positive valence bias show surprise-related activity in brain regions that are recruited when asked to cognitively reappraise negatively valence stimuli (Petro et al., 2018).

Last, the developmental findings described above also support the INH because children do not typically have the regulatory mechanisms in place to help them to overcome this initial negativity (Gee et al., 2013). Indeed, children in later stages of pubertal development who maintained a more immature (positive) pattern of connectivity between the amygdala and medial prefrontal cortex (mPFC) were more likely to show a negative valence bias. In contrast, children who had developed a more mature (inverse) connectivity pattern showed a more positive valence bias (Petro et al., 2021). In other words, a more positive valence bias seems to develop alongside a pattern of amygdala-mPFC connectivity that is suggestive of more effective emotion regulation.

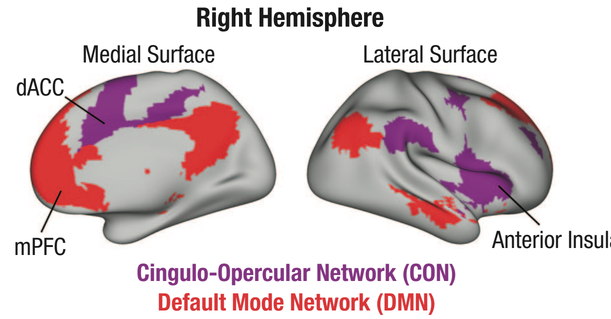

Fig. 2. Map of relevant brain networks superimposed on the right hemisphere of the human brain. The medial surface, which is the middle (inside) of the brain looking rightward, is shown on the left; the lateral surface, which is the right (outside) of the brain, is shown on the right. The CON, which includes the dACC and the anterior insula, is represented in purple. The DMN, which includes the mPFC, is represented in red. CON = cingulo-opercular network; dACC = dorsal anterior cingulate cortex; DMN = default model network; mPFC = medial prefrontal cortex.

Expanding the Brain Circuitry of Emotion

Extensive research in this domain has focused on the amygdala as an initial response center and prefrontal regions, such as the mPFC, that serve to regulate these responses. Indeed, all of the neuroimaging findings described up to this point have fit squarely in this space. But more recent neuroscience research emphasizes the importance of multiple brain networks that likely work together to produce these behavioral outcomes.

For example, earlier studies of valence bias made an unexpected discovery. When participants were asked to categorize ambiguous faces and scenes in the MRI, rather than finding activation in the amygdala or mPFC, robust activation of the cingulo-opercular network (CON) was observed (Neta et al., 2013). The CON, often conflated with but distinct from the salience network (Uddin et al., 2023), includes a set of regions in the dorsal (top) anterior cingulate cortex and the bilateral anterior insula (beneath the temples) that seems to support task control (Fig. 2) and has more recently been renamed the "action-mode network" (Dosenbach et al., 2025). A series of studies found that the CON was active when participants were asked to make a judgment that resolves the ambiguity across domains (e.g., making valence judgments about dual-valence ambiguity, making semantic judgments about auditorily presented homophones; Neta et al., 2013, 2014).

Newer evidence suggests that this CON not only plays an important role when being asked to resolve ambiguity but also shows effects specifically supporting a more positive valence bias (Pierce et al., 2023). To elaborate, using resting-state functional MRI to characterize individual differences in intrinsic brain organization, a recent study identified the CON as playing a key role in distinguishing individuals with a more positive versus negative valence bias across the lifespan (ages 6–80; Pierce et al., 2024). That is, greater connectivity between the CON and other brain networks, such as the default mode network, widely implicated in self-referential processing and with emotional dysfunction (Raichle, 2015), was associated with a more positive valence bias (Pierce et al., 2024).

An important takeaway from this work is that there are widespread brain regions and systems that support complex behavioral processes such as decision-making during ambiguous emotional situations (Pessoa, 2017). Future work should move away from the notion of hot and cold cognition or systems, which separate emotional from logical or analytical mental processes, and foster a greater appreciation for the interconnectedness of the human brain. As evidenced here, the putative hot and cold systems are integrated, necessarily so, to produce a particular emotional response. Similarly, instead of reporting activation in a set of discrete brain regions, we can further consider whether and how these regions—such as the dorsal anterior cingulate and bilateral anterior insula, which are recruited across a great many tasks (Nelson et al., 2010) but also make up the core of the CON—are working in concert as components in whole brain systems.

Implications for Translational Science

These studies supporting the INH and the importance of regulating the initial negativity for adaptive emotional functioning have far-reaching implications for the field. For example, a more negative valence bias is associated with increased depression and anxiety across the lifespan (Neta & Brock, 2021; Petro et al., 2021), increased stress reactivity (Brown et al., 2017) and loneliness (Harp & Neta, 2023), and decreased social connectedness (Neta & Brock, 2021). These results are consistent with a recent review noting that cognitive biases, including biases in interpretation—like the valence bias—are predictive of future symptoms of depression and anxiety (Vos et al., 2025). Together, these findings are consistent with the notion that valence bias may be a transdiagnostic affective risk factor (Clinchard et al., 2024).

Beyond pathological symptomatology, valence bias can also be shown to have a more nuanced relationship with psychological well-being. For example, valence bias—even more so than other tasks that measure negative interpretation bias—was associated with variability in both positive and negative daily affect across a period of months (Puccetti et al., 2023). In other words, a more negative valence bias was associated with increased negative and decreased positive daily affect (and the reverse was true for a more positive valence bias).

Valence bias may also have important implications for physical health. For example, the link between negative valence bias and adverse health outcomes can be considered through the lens of the generalized unsafety theory of stress (GUTS; Brosschot et al., 2018). The GUTS posits that the stress response is the biological default, maintained by the absence of perceived safety rather than the presence of explicit threat. In other words, the body may remain in a state of chronic physiological arousal, which is associated with cardiovascular disease, depression, and all-cause mortality (Brosschot et al., 2018). Because ambiguous stimuli lack inherent safety cues, they may perpetuate a state of "generalized unsafety." However, individuals with a positive valence bias may effectively generate a "safety signal" that recruits regulatory (e.g., prefrontal, vagal) pathways to downregulate arousal. In contrast, individuals with a negative valence bias fail to generate this safety signal, resulting in prolonged disinhibition of the sympathetic nervous system and the associated physiological wear and tear.

Given this breadth of evidence linking negative valence bias with adverse outcomes, why might the initial negativity be adaptive? There are a number of possibilities. First, and perhaps most simply, humans prioritize negativity, allowing them to prepare the body for immediate action in the event of a potential threat; this prioritization may be particularly evident in early life (i.e., when a negativity bias is more common; Vaish et al., 2008). Second, error management theory suggests that the brain is biased toward the least costly error, and in the decision between threats and rewards, failing to detect a threat (i.e., displaying a positive valence bias) is more costly (Haselton & Nettle, 2006). By this logic, one might argue that the regulatory processes that help to overcome the initial negativity are most likely in safe environments; and in these situations, a positive bias may instead be more adaptive.

Conclusions and Future Directions

Although much has been learned from studies using stimuli of clear valence—fear, anger, joy—there is much also to be learned from studies of ambiguous valence. Our work has programmatically demonstrated that there are stable and reliable individual differences in valence bias and that this bias shapes not only responses to emotional faces but also scenes and words. The working model outlined here suggests that the default response to ambiguity, at least in the first half of life, is negative, and that a more positive bias relies on regulatory mechanisms likely akin to cognitive reappraisal. Findings based on this model have provided support for the idea that valence bias may predict self-reports of daily psychological well-being as well as depressive and anxious pathological symptomatology. The possibility that valence bias may function as a transdiagnostic risk factor for pathological outcomes warrants future research exploring the potential effect of bias-shifting interventions. As an example, some early evidence has shown that mindfulness-based stress reduction produces a more positive valence bias (Harp et al., 2022) and, more notably, that this shift toward positivity uniquely explained a reduction in symptoms of depression and anxiety (Harp et al., 2024). In the next several decades of research, a greater focus on ambiguity will likely yield important insights for early detection and treatment and for promoting health and well-being across the lifespan. For example, future studies that integrate valence bias with related theories about stress (e.g., the GUTS) and test implications for these processes on subsequent memory may help explain important connections with physical and mental health.

Last, future work should examine any similarities in the mechanisms supporting responses to dual-valence ambiguity—including developmental, cognitive, and neural mechanisms—with responses to other types of ambiguity to determine the extent to which these processes are unique to emotional ambiguity. For example, although some work has demonstrated that the neural mechanisms described here, including the CON, support responses to ambiguity in other domains (e.g., semantic processing, visual object recognition; Neta et al., 2014, 2017), the cognitive and developmental effects (e.g., the extent to which there is a strong bias to resolve these ambiguities in one direction or another, the extent to which these biases shift over the lifespan) are not well enough studied across domains to draw comparisons. These efforts would forge a new frontier of work examining the myriad ways humans confront and resolve ambiguity.

Recommended Reading

Neta, M. (2024). (See References). Reviews the literature on valence bias and describes valence bias as a trait-like measure that is consequential and malleable.

Neta, M., Harp, N. R., Tong, T. T., Clinchard, C. J., Brown, C. C., Gross, J. J., & Uusberg, A. (2023). Think again: The role of reappraisal in reducing negative valence bias. *Cognition and Emotion*, *37*(2), 238–253. Uses experimental methods to demonstrate that cognitive reappraisal—specifically, reinterpretation—is uniquely involved in arriving at a positive categorization of ambiguous stimuli.

Pessoa, L. (2017). (See References). Reviews the literature on brain regions implicated in emotion and pushes instead for a broader circuitry that should be considered in the study of emotion in humans and nonhuman animals.

Pierce, J. E., Wig, G. S., Harp, N. R., & Neta, M. (2024). (See References). Uses neuroimaging methods to examine individual differences in brain organization that explain one's valence bias.

Varkevisser, T., Geuze, E., & van Honk, J. (2024). (See References). Reviews the amygdala-centric view on affective neuroscience and examines findings across different research methods and domains.

Transparency

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References

Brosschot, J. F., Verkuil, B., & Tshayer, J. F. (2018). Generalized unsafety theory of stress: Unsafe environments and conditions, and the default stress response. *International Journal of Environmental Research and Public Health*, *15*(3), Article 464. https://doi.org/10.3390/ijerph15030464

Brown, C. C., Raio, C. M., & Neta, M. (2017). Cortisol responses enhance negative valence perception for ambiguous facial expressions. *Scientific Reports*, *7*, Article 15107. https://doi.org/10.1038/s41598-017-14846-3

Carstensen, L. L., & DeLiema, M. (2018). The positivity effect: A negativity bias in youth fades with age. *Current Opinion in Behavioral Sciences*, *19*, 7–12.

Chang, M., & Brainerd, C. J. (2021). Semantic processing of emotional ambiguity. *Emotion*, *21*(5), 963–975.

Clinchard, C., Harp, N. R., Lorenz, T., & Neta, M. (2024). Proposing a model whereby negative valence bias increases the risk for more severe dysphoric posttraumatic stress disorder and depression symptomology. *Emotion*, *24*(5), 1169–1179.

Dosenbach, N. U., Raichle, M. E., & Gordon, E. M. (2025). The brain's action-mode network. *Nature Reviews Neuroscience*, *26*(3), 158–168.

Freeman, J. B., & Ambady, N. (2010). MouseTracker: Software for studying real-time mental processing using a computer mouse-tracking method. *Behavior Research Methods*, *42*(1), 226–241.

Gee, D. G., Humphreys, K. L., Flannery, J., Goff, B., Telzer, E. H., Shapiro, M., Hare, T. A., Bookheimer, S. Y., & Tottenham, N. (2013). A developmental shift from positive to negative connectivity in human amygdala–prefrontal circuitry. *Journal of Neuroscience*, *33*(10), 4584–4593.

Harp, N. R., Blair, R. J. R., & Neta, M. (2024). Shift in valence bias associated with decrease in trait anxiety and depression symptoms. *Cognitive Therapy and Research*, *48*(3), 444–450.

Harp, N. R., Brown, C. C., & Neta, M. (2021). Spring break or heart break? Extending valence bias to emotional words. *Social Psychological and Personality Science*, *12*(7), 1392–1401.

Harp, N. R., Freeman, J. B., & Neta, M. (2022). Mindfulness-based stress reduction triggers a long-term shift toward more positive appraisals of emotional ambiguity. *Journal of Experimental Psychology: General*, *151*(9), 2160–2172.

Harp, N. R., & Neta, M. (2023). Tendency to share positive emotions buffers loneliness-related negativity in the context of shared adversity. *Journal of Research in Personality*, *102*, Article 104333. https://doi.org/10.1016/j.jrp.2022.104333

Haselton, M. G., & Nettle, D. (2006). The paranoid optimist: An integrative evolutionary model of cognitive biases. *Personality and Social Psychology Review*, *10*(1), 47–66.

Hirsch, C. R., Meeten, F., Krahé, C., & Reeder, C. (2016). Resolving ambiguity in emotional disorders: The nature and role of interpretation biases. *Annual Review of Clinical Psychology*, *12*(1), 281–305.

Nelson, S. M., Dosenbach, N. U., Cohen, A. L., Wheeler, M. E., Schlaggar, B. L., & Petersen, S. E. (2010). Role of the anterior insula in task-level control and focal attention. *Brain Structure and Function*, *214*(5), 669–680.

Neta, M. (2024). Valence bias: Individual differences in response to ambiguity. In J. Gross & B. Ford (Eds.), *Handbook of emotion regulation* (3rd ed., pp. 242–249). Guilford Press.

Neta, M., Berkebile, M. M., & Freeman, J. B. (2021). The dynamic process of ambiguous emotion perception. *Cognition and Emotion*, *35*(4), 722–729.

Neta, M., & Brock, R. L. (2021). Social connectedness and negative affect uniquely explain individual differences in response to emotional ambiguity. *Scientific Reports*, *11*, Article 3870. https://doi.org/10.1038/s41598-020-80471-2

Neta, M., Davis, F. C., & Whalen, P. J. (2011). Valence resolution of ambiguous facial expressions using an emotional oddball task. *Emotion*, *11*(6), 1425–1433.

Neta, M., & Dodd, M. D. (2018). Through the eyes of the beholder: Simulated eye-movement experience ("SEE") modulates valence bias in response to emotional ambiguity. *Emotion*, *18*(8), 1122–1127.

Neta, M., Kelley, W. M., & Whalen, P. J. (2013). Neural responses to ambiguity involve domain-general and domain-specific emotion processing systems. *Journal of Cognitive Neuroscience*, *25*(4), 547–557.

Neta, M., Nelson, S. M., & Petersen, S. E. (2017). Dorsal anterior cingulate, medial superior frontal cortex, and anterior insula show performance reporting-related late task control signals. *Cerebral Cortex*, *27*(3), 2154–2165. https://doi.org/10.1093/cercor/bhw053

Neta, M., Norris, C. J., & Whalen, P. J. (2009). Corrugator muscle responses are associated with individual differences in positivity-negativity bias. *Emotion*, *9*(5), 640–648.

Neta, M., Schlaggar, B. L., & Petersen, S. E. (2014). Separable responses to error, ambiguity, and reaction time in cingulo-opercular task control regions. *Neuroimage*, *99*, 59–68.

Neta, M., & Tong, T. T. (2016). Don't like what you see? Give it time: Longer reaction times associated with increased positive affect. *Emotion*, *16*(5), 730–739.

Neta, M., & Whalen, P. J. (2010). The primacy of negative interpretations when resolving the valence of ambiguous facial expressions. *Psychological Science*, *21*(7), 901–907.

Pessoa, L. (2017). A network model of the emotional brain. *Trends in Cognitive Sciences*, *21*(5), 357–371.

Petro, N. M., Tong, T. T., Henley, D. J., & Neta, M. (2018). Individual differences in valence bias: fMRI evidence of the initial negativity hypothesis. *Social Cognitive and Affective Neuroscience*, *13*(7), 687–698.

Petro, N. M., Tottenham, N., & Neta, M. (2021). Exploring valence bias as a metric for frontoamygdalar connectivity and depressive symptoms in childhood. *Developmental Psychobiology*, *63*(5), 1013–1028.

Pierce, J. E., Petro, N. M., Clancy, E., Gratton, C., Petersen, S. E., & Neta, M. (2023). Specialized late cingulo-opercular network activation elucidates the mechanisms underlying decisions about ambiguity. *NeuroImage*, *279*, Article 120314. https://doi.org/10.1016/j.neuroimage.2023.120314

Pierce, J. E., Wig, G. S., Harp, N. R., & Neta, M. (2024). Resting-state functional network segregation of the default mode network predicts valence bias across the lifespan. *Imaging Neuroscience*, *2*. Article imag-2-00403. https://doi.org/10.1162/imag_a_00403

Puccetti, N. A., Villano, W. J., Stamatis, C. A., Hall, K. A., Torrez, V. F., Neta, M., Timpano, K. R., & Heller, A. S. (2023). Negative interpretation bias connects to real-world daily affect: A multistudy approach. *Journal of Experimental Psychology: General*, *152*(6), 1690–1704.

Raichle, M. E. (2015). The brain's default mode network. *Annual Review of Neuroscience*, *38*(1), 433–447.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, *110*(1), 145–172.

Tottenham, N., Phuong, J., Flannery, J., Gabard-Durnam, L., & Goff, B. (2013). A negativity bias for ambiguous facial-expression valence during childhood: Converging evidence from behavior and facial corrugator muscle responses. *Emotion*, *13*(1), 92–103.

Uddin, L. Q., Betzel, R. F., Cohen, J. R., Damoiseaux, J. S., De Brigard, F., Eickhoff, S. B., Fornito, A., Gratton, C., Gordon, E. M., Laird, A. R., Larson-Prior, L., McIntosh, A. R., Nickerson, L. D., Pessoa, L., Pinho, A. L., Poldrack, R. A., Razi, A., Sadaghiani, S., Shine, J. M., . . . Spreng, R. N. (2023). Controversies and progress on standardization of large-scale brain network nomenclature. *Network Neuroscience*, *7*(3), 864–905.

Vaish, A., Grossmann, T., & Woodward, A. (2008). Not all emotions are created equal: The negativity bias in social-emotional development. *Psychological Bulletin*, *134*(3), 383–403.

Varkevisser, T., Geuze, E., & van Honk, J. (2024). Amygdala fMRI—A critical appraisal of the extant literature. *Neuroscience Insights*, *19*. https://doi.org/10.1177/26331055241270591

Vos, L. M., Nieto, I., Amanvermez, Y., Smeets, T., & Everaert, J. (2025). Do cognitive biases prospectively predict anxiety and depression? A multi-level meta-analysis of longitudinal studies. *Clinical Psychology Review*, *116*, Article 102552. https://doi.org/10.1016/j.cpr.2025.102552