Things Change—But When?

A Top-Down Approach to Understanding How People Judge Change Thresholds

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Abstract

Things change. And yet, the precise point at which they do—i.e., the change threshold—is often harder for people to discern, especially in rich everyday domains of self and social judgment (e.g., judging the precise point at which one's relationship has "officially" eroded or the precise point at which bad actors have "officially" reformed). The traditional approach to understanding people's crossing of these change thresholds has assumed a more bottom-up process: Here the assumption is that things change at some objective, external, and stable point, within the stimulus (vs. within the perceiver)—which people can passively detect so long as they have the right tools. In contrast, the current chapter approaches this issue through the lens of a more top-down process: Here the assumption is that things change at a subjective, internal, and dynamic point, within the perceiver (vs. within the stimulus)—which people actively construct on the spot. The current chapter reviews diverse and converging evidence in support of this top-down approach. Ultimately, I argue that by understanding people's crossing of change thresholds as a top-down (vs. bottom-up) process, psychological research on change judgment can advance more nuanced insights into when and why people judge change (in)accurately.

Things Change—But When?

A Top-Down Approach to Understanding How People Judge Change Thresholds

The only constant in life is change—thereby begging the question: How do people make sense of a world that is constantly in flux? One psychological strategy that people seem to widely utilize is to delineate continuous change into simpler categorical buckets. That is, people often work to establish evaluative thresholds for judging when *something* has transformed into something *else*. From a legal perspective, a child "officially" becomes an adult when they cross the age of 18 years in some countries (Hamilton, 2016); from a medical perspective, a healthy person "officially" becomes feverish when their temperature crosses 100.4° Fahrenheit (Garner et al., 1988); from a geological perspective, the Earth will "officially" hit the point of no return in climate change when its average temperature crosses 1.5° Celsius above preindustrial levels (Aengenheyster et al., 2018); and so forth.

In some cases—such as in the examples above—people's rationale for where to set these thresholds for change can be traced to a seemingly objective standard; judging change is straightforward. In many other cases, however, judging change is more complicated. For example, at what point does a romantic relationship "officially" transform from destined to doomed? At what point does one's fluctuating mood "officially" transform into troubling signs of despair? At what point does a past offender "officially" transform into a reformed success?

These latter examples highlight the fact that judging change can be highly subjective, and thus can be influenced by how people psychologically construe what has transpired—beyond, for example, people passively responding to objective degrees of difference out in the world. The goal of this chapter is to review empirical evidence in support of this active top-down approach to understanding how people judge change thresholds (as compared to the traditional or

"normative" view—which takes a more passive bottom-up approach). Ultimately, I argue that shifting toward a top-down model of how people judge change thresholds would help advance the literature on change judgment by theoretically unpacking where people's priors for change come from in the first place, beyond simply modeling inherent future uncertainty. In doing so, we can better understand when and why people judge change (in)accurately.

First, this chapter reviews the traditional (i.e., bottom-up) approach to understanding how people judge change thresholds. Second, and in contrast, this chapter reviews evidence for a more top-down approach. Third, this chapter raises new questions and future directions for research on change judgment, as a function of adopting a more top-down approach to understanding how people subjectively (vs. objectively) cross change thresholds.

I. Crossing Change Thresholds: The Bottom-Up Approach (Traditional View)

Change is inherent to everyday life. As such, it is unsurprising that scholars across many fields have long been interested in understanding it. As early as around 500 BCE, the Greek philosopher Heraclitus argued that change is an essential physical law of the universe, and is reported to have stated what is famously transcribed as "You cannot step into the same river twice" (Heraclitus, Flux, 3.1, B12). In the 1600s, Sir Isaac Newton sought to develop a systematic framework, built into the mathematical study of calculus, for charting and predicting how distant objects continuously change their spatial locations (Baron, 1969). And still today, diverse fields from history to economics are aimed at creating organizing principles for making sense of past change and forecasting future change (Staley, 2002).

These are just some examples of humanity's long history of trying to understand external change out in the world. Note, however, that in all these examples, the assumption is that things "out there" do change at some objectively measurable point, independent of people needing to be

around to perceive it; things transform from *something* to something *else*, and therefore the resulting goal has been to develop tools to help us calculate these changes or differences between before and after.

In turn, the study of change within the field of psychology also appears to have been inspired by this traditional approach—that is, psychology has its own history of a more bottom-up approach to change thresholds that paints people as perceiving change by passively intaking the presence of differences out in the world. Below I review three prominent lines of psychological research that have grown out of this tradition of assuming that people *objectively* cross change thresholds.

Crossing change thresholds via basic attention. Perhaps the most commonly investigated psychological feature of change perception is basic attention. The assumption here is that people judge change by simply noticing it out in the world—and thus interesting findings have emerged in this literature by highlighting factors that disrupt people's ability to notice. For example, people are found to *fail* to cross change thresholds when change unfolds too gradually to be appreciated (e.g., Simons et al., 2000) or when people become desensitized to its presence (e.g., Campbell et al., 2014; O'Brien & Smith, 2019). The (morally objectionable) metaphor of the "boiling frog" captures these ideas: A frog might immediately jump out of boiling water, but continue to sit in water that begins lukewarm and gradually raises to boiling. Again, however, note the assumption: If water "officially" boils at 212° Fahrenheit (Chang, 2008), the focus is simply on people's (in)ability to notice when 212° has been crossed (i.e., the assumption is that objective thresholds exist, to which people simply passively react).

In this same way, other research finds that people often miss the crossing of change thresholds because of competing distractions on their limited attention (Beck et al., 2001;

Grimes, 1996; Pashler, 1988; Rensink, 2002; Wilken & Ma, 2004). In "change blindness" studies, for instance, people miss ostensibly obvious changes (e.g., the surveying experimenter is swapped with a different person; a comical gorilla dances across the video playing right in front of one's eyes) to the extent that they are stuck in complex informational environments (e.g., when the swap occurs on a crowded public street with many other happenings; when people are required to complete cognitive tasks while the gorilla dances by; see Chabris & Simons, 2010; Simons & Ambinder, 2005). Likewise, some stimulus features are naturally harder to notice than others—thus leading researchers to demonstrate how easy it can be to disrupt people's ability to notice the crossing of change thresholds that involve those features (e.g., subtractive change is sometimes harder to notice than additive change: Adams et al., 2021; Agostinelli et al., 1986; visual change is sometimes harder to notice than auditory change: Demany et al., 2008). Throughout, change thresholds are assumed—such that entities exist "out there," with people struggling to notice when those thresholds are crossed.

Crossing change thresholds via impression updating. Another commonly investigated psychological feature of change perception comes in the form of basic learning principles— namely, principles of impression updating. Similar to the notion of attention, the assumption here is that people simply cross change thresholds by operating as rational Bayesians (for a review, see Kim et al., 2020; also Massey & Wu, 2005): When people observe evidence of change, they attempt to weigh its diagnostic value and then update their change judgments accordingly—they either move closer to or further away from crossing the threshold, as a function of the observed evidence. This process has been studied by focusing on explicit levels, further confirming an assumption of a straightforward updating response (e.g., Gawronski & Bodenhausen, 2006; Gregg et al., 2006). However, it also occurs more implicitly. In one study, for example,

researchers tested the extent to which people change their negative categorizations of a target

stimulus (e.g., an image of a person with a disfigured face) to positive categorizations—and

indeed, even at the implicit level (e.g., via changes in scores on the Implicit Association Test:

Greenwald et al., 1998), participants dutifully updated their impressions when provided with new

evidence for change that was of high diagnostic value (e.g., discovering that the disfigurement

was caused by a heroic act, like saving a child from a house fire: Mann & Ferguson, 2015).

Throughout this research, however, note again that the key point is its assumption about

change thresholds: People's crossing of change thresholds—for example, when and why they

judge a negative target as "officially" positive instead—reflects their response to genuine

changes that they notice (or not) out in the world. The threshold is assumed to be external,

objective, and stable to one's judgment of crossing it.

Absolute threshold theory. Finally, the perspective presented thus far was broadly

captured and formalized by early psychological research on absolute threshold theory (for

reviews across numerous applications, see Engen, 1971; Kellen & Klauer, 2018; Rotello, 2017).

Absolute threshold theory was first proposed and examined in the context of how people

perceive sensory changes in the environment. According to the theory, sensory stimuli vary in

their psychological detectability, which early researchers sought to establish by presenting a

sensation (e.g., a particular light or noise) at gradually increasing levels until it became reliably

detectable to the human ear—a point that was often referred to as the just-noticeable difference,

defined as the smallest level of a stimulus that a participant was able to detect 50% of the time

(Levine & Shefner, 1981). The theory takes a bottom-up approach to understanding people's

crossing of change thresholds, as it takes as a given that thresholds—at least as studied in these

basic contexts of sensation and perception—exist "out there" and "within the stimulus." For

example, imagine a person is exposed to a harmful noise at a level that crosses its absolute threshold that is predetermined by the operational definition. Now imagine that the person is so extensively exposed to the noise (e.g., perhaps they live near a noisy train that runs at regular intervals) such that they experience feelings of desensitization (e.g., they stop noticing the noise). A prediction from absolute threshold theory is that people should still be bothered by the noise—because the "objective" level of the stimulus remains constant at crossing its threshold.

Although early research on absolute threshold theory was largely restricted to simple sensory stimuli such as the presence of noises and so on (as opposed to, for example, extending to richer and more ambiguous social judgments), similar conceptual assumptions can be found in research from elsewhere. For example, there is interesting research in the field of judgment and decision making arguing that the number three often demarcates people's perceptions of a meaningful streak, and thus it is often used as an external threshold for passing judgment—as reflected in the Latin proverb *omne trium est perfectum* ("every set of three is complete"), and also, more colloquially, in the often-set threshold of "3 strikes and you're out" (e.g., Carlson & Shu, 2007; Shu & Carlson, 2014; Tyler & Boeckmann, 1997; Uslay et al., 2010). These examples highlight the bottom-up approach because the underlying assumption across them is that there is a context-independent "nature" that exists within change thresholds—so long as stimuli come in sets of three (as opposed to, for example, assuming that the meaning of three might vary across stimuli, people, situations, and so forth).

II. Crossing Change Thresholds: The Top-Down Approach (Proposed View)

In contrast to this traditional bottom-up approach to understanding how people cross change thresholds—which, as reviewed, assumes an objective externality to such thresholds that people do or do not attend to—I highlight a *top-down* approach. This top-down approach can be
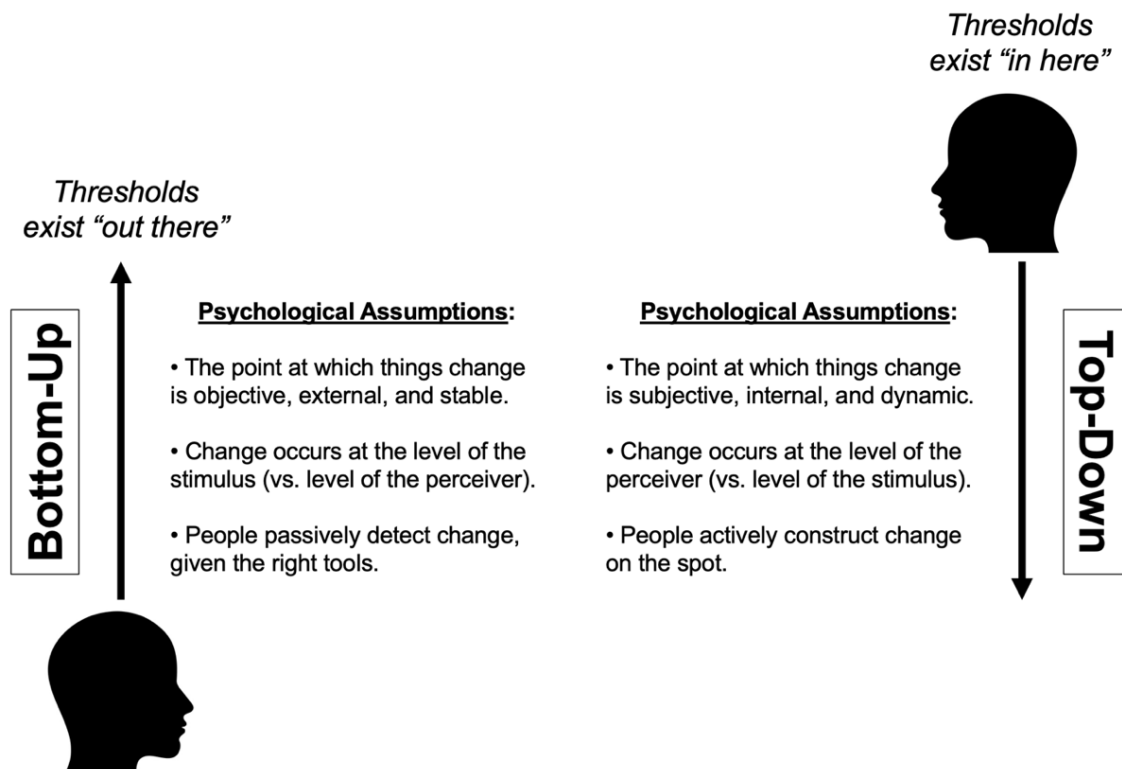
uniquely applied to understanding richer and more ambiguous social judgments, which pervade

everyday life (e.g., understanding how observers judge the point at which a good actor

"officially" falls from grace, or the point at which a bad actor "officially" reforms). This is

because such a top-down approach rejects an assumption about objective externality; instead, it

assumes that people *subjectively and actively construct change thresholds on the spot*—an

assumption that is consistent with more general context-based models of attitude formation (e.g.,

situated cognition and cognitive tuning: Schwarz, 2002, 2007). Returning to the "noisy train"

example from above, the prediction from this top-down perspective is *not* that people should

perceive the noise whether or not they desensitize to it due to their previous experiences (as

predicted by absolute threshold theory); in contrast, the prediction is that people may or may not

perceive it, because there is no objective threshold for detection that are common to all humans.

The error or noise that explained individual differences to detect change threshold, and thus,

must be eliminated in the bottom-up approach is seen as a critical factor in the top-down

approach. Figure 1 provides a visual depiction of these two contrasting approaches to

understanding how people cross change thresholds.

Indeed, as research on absolute threshold theory progressed, there emerged a contrasting

and more psychologically nuanced perspective in the form of *signal detection theory*—which is

among the most influential theories in psychology, and bears directly on a top-down approach to

understanding change thresholds (for reviews across numerous applications, see Green & Swets,

1966; Pastore & Scheirer, 1974; Wixted, 2020). According to signal detection theory, the

psychological detectability of stimulus change does not depend on inherent features of the

stimulus but instead on the context in which perceivers evaluate it. For example, people might be

more vs. less motivated to judge something as changed, or have an easier vs. harder time to judge

something as changed, and so forth. Signal detection theory posits that such factors should also influence people's crossing of change thresholds, despite holding constant "absolute" levels of

Figure 1. A bottom-up approach (the more traditional view) vs. a top-down approach (the proposed view in the current chapter) to understanding people's crossing of change thresholds.

Thresholds exist "in here"

Thresholds exist "out there"

Bottom-Up

Psychological Assumptions:

• The point at which things change is objective, external, and stable.

• Change occurs at the level of the stimulus (vs. level of the perceiver).

• People passively detect change, given the right tools.

Psychological Assumptions:

• The point at which things change is subjective, internal, and dynamic.

• Change occurs at the level of the perceiver (vs. level of the stimulus).

• People actively construct change on the spot.

Top-Down

difference. Weber's Law (see, e.g., Wixted, 2020) simply but intuitively illustrates this effect in action, as it states that people's ability to detect marginal change will decrease as the absolute intensity of the stimulus increases. For example, the sudden appearance of 10 dots will immediately elicit perceptions of change within a visual space of one dot, but may go unnoticed

within a visual space of 1,000 dots—despite the fact that whatever influence "10 dots" should wield in shifting people's crossing of change thresholds is identical in both cases.

This logic can be applied to better understanding people's crossing of change thresholds in richer domains of self and social judgment (for instance), which often lack true objective thresholds "out there" and hence demand a top-down explanation. A philosophical conundrum dubbed the "paradox of the heap" illustrates this point, which in one form is stated as follows: "Is one grain of sand a heap of sand?" The answer is no. If a second grain is added to the first, is there a heap? Again the answer is no. If a third grain is added, is there a heap? For a third time the answer is no" (Fisher, 2000). And so it goes, *ad infinitum*.

People's crossing of change thresholds in much of everyday life often amounts to such a subjective judgment, perhaps more than people realize or care to admit. The critical question of psychological interest, then, is: How do people go about forming these thresholds? Answering this question can be difficult by taking a bottom-up approach, because the assumption is that thresholds exist and do not need to be "formed"—yet it becomes clearer by taking a top-down approach. Below I highlight three recent examples.

Example 1: Crossing change thresholds via perceived diagnosticity

By direct experience, people dynamically learn about particular informational relationships in their environments. This process of learning leads people to infer a sense of *perceived diagnosticity* about a possible signal of change (e.g., "Does this map onto what usually happens here?")—and, in turn, people draw on perceived diagnosticity for crossing a change threshold. In other words, different contexts will elicit different change thresholds depending on one's learning environment, even when the actual stimulus and its "objectively measured" intensity level are held constant.

Pioneering research on this front (Skowronski & Carlston, 1987, 1989) examined two contrasting domains to highlight this role of perceived diagnosticity: the ability domain vs. the morality domain. In the *ability* domain, signs of positive change are typically more diagnostic than signs of negative change for discriminating between alternative trait categorizations, as naturally learned in typical everyday life. This has been shown to produce *positivity* biases in change judgment. For example, imagine you are tracking a student's math performance over time and are tasked with detecting the point at which they are "officially" improving or declining in their abilities. According to this model of perceived diagnosticity, you will cross these change thresholds asymmetrically, such that you will need to see just a few exceptional performances before concluding that they are improving whereas you will need to see many struggling performances before concluding that they are declining (i.e., a positivity bias). This is because you have learned these typical associations by virtue of living everyday life: Non math-whizzes cannot perform exceptionally on math tasks whereas true math-whizzes can sometimes struggle on math tasks.

In the *morality* domain, this relationship is flipped: Signs of negative change are typically more diagnostic than signs of positive change for discriminating between alternative trait categorizations, as naturally learned in typical everyday life—thus producing asymmetric *negativity* biases in change judgment. For example, imagine you are tracking potential changes in a person's honest moral character over time. According to the model, you will need to see many honest behaviors before concluding that they are moral whereas you will need to see just a few dishonest behaviors before concluding that they are immoral (i.e., a negativity bias). This is the result of the same diagnostic learning process as above, simply reflecting the reverse

association as it is learned in everyday life: Honest people cannot lie whereas liars can sometimes be honest.

Finally, these findings on perceived diagnosticity highlight the asymmetric role of valence across change judgments. In domains of social judgment that lie closer to the morality (vs. ability) end of the spectrum—for example, the points at which observers judge good actors as having fallen from grace or judge bad actors as truly reformed—one should expect a robust negativity bias in change judgment. This is what research by O'Brien and colleagues has consistently found—using people's differential crossing of change thresholds as the dependent measure (e.g., Klein & O'Brien, 2016; O'Brien, 2020, 2022; O'Brien & Klein, 2017).

Example 2: Crossing change thresholds via perceived salience

Another example that highlights the role of an active top-down process in people's crossing of change thresholds is in the form of the *perceived salience* of the target of judgment, which can be influenced by an array of stimulus-independent forces. Higher perceived salience hastens people's crossing of change thresholds whereas lower perceived salience slows it— again, even when the actual stimulus and its "objective" intensity level are held constant.

An illustrative theory on this front is Ross's (1989) inference-based model of how people judge their own change vs. stability across different life stages and events. According to the model, salient reminders of possible change lead people to infer that they must have changed after all—even when this does not correspond to reality. That is, people draw on incidental salience to cross change thresholds. For example, in one study (Conway & Ross, 1984), participants who were randomly assigned to complete a study-skills course later inferred that their test scores *must* have changed by a wider margin than participants who did not take the course—regardless of how much their scores actually changed from before and after. In another

study (Eibach et al., 2003), participants made various judgments about the extent to which they believed states of the world have gotten worse over time (e.g., whether a rising crime rate had crossed the threshold of getting too dangerous). Interestingly, participants who had (vs. had not) recently become parents reported higher rates of diagnosing the world as "more" dangerous, suggesting that such changes in self-states increased the salience of motivationally relevant signals for possible decline (e.g., it was argued that new parents become more alert to potential threats to safety)—despite being independent of any "objective" change. Many other such examples have been discovered whereby people are found to predict higher (vs. lower) change when change-relevant states are more (vs. less) salient at the time of prediction in a series of studies conducted by O'Brien and colleagues (e.g., Kardas & O'Brien, 2018; Kristal et al., 2019; O'Brien, 2013, 2019, 2021; O'Brien et al., 2012; O'Brien et al., 2018; O'Brien & Roney, 2017). Cultural differences in which features of change are more vs. less salient also guide people's crossing of change thresholds (e.g., Ji et al., 2001), as do differences in the available information that surrounds those focal features at the time of judgment (e.g., Levari et al., 2018).

This notion of differential salience producing differential change judgments highlights a broader point: There exists a reliable *self-other difference* in change judgment, such that people are quicker to believe that they themselves have improved over time, as compared to people believing that others have improved over the same period—precisely due to the fact that such motivationally relevant self-states (e.g., one's underlying efforts in working hard to improve) are more salient to people than other-states (e.g., O'Brien, 2015a, 2015b; O'Brien & Kardas, 2016; Quoidbach et al., 2013; Wilson & Ross, 2001). In one study, Klein and O'Brien (2017) found that people are quicker to cross the threshold for reform (e.g., believing a bad target has "officially" gotten better) when judging their own past bad actions vs. others' past bad actions,

due to this differential salience of underlying states (e.g., one's hard work to reform). Put another way: People are quicker to cross certain change thresholds when *they themselves* are the target of judgment, holding constant the actual "objective" evidence for crossing the threshold—at least in domains of working towards improvement.

Example 3: Changing thresholds for change

A final example that highlights the role of an active top-down process in people's crossing of change thresholds is found in recent research on the *time-course* of crossing change thresholds (Klein & O'Brien, 2018, 2022), which finds that people dynamically shift their own self-set thresholds for judging change depending on what unfolds—even when people are first informed about what all might unfold beforehand.

In these studies, Klein and O'Brien asked participants to indicate their threshold for judging change at two time points: first, before any of those requisite behaviors unfolded ("Time 1"); and second, as those requisite behaviors unfolded piece by piece ("Time 2"). For example, participants were informed that they would view a target's behavior across a certain number of observations (e.g., getting to see whether someone cheated or not in an economic game, across a series of 10 such games). At Time 1, they were asked to predict their threshold for passing dispositional judgment about the target's character. Critically, before predicting this threshold, participants were asked to imagine all the ways in which these requisite behaviors could unfold—ranging from especially egregious versions (e.g., aggressively cheating right away in the first 4 games in a row, as compared to spreading them out) to especially mild versions (e.g., cheating occasionally as needed, simply for prosocial or otherwise understandable reasons)—and were instructed to assume that any combination of such ways is equally likely to unfold. Taking all these possibilities together, participants were therefore asked to indicate their threshold (e.g.,

a participant might say: "If they end up cheating in 5 of these 10 games—assuming it could be *any* of these versions of cheating—that's my threshold; that's when I'd judge them as a truly bad actor"). Then, at Time 2, participants were each observation unfold piece by piece—whereby they learned whether the target actually hit the threshold (e.g., they learned that the target cheated in 5 or more of the games, or only in 4 or fewer of the games)—and at the end, reported whether they pass dispositional judgment.

What Klein and O'Brien found was that they could systematically influence people's real-time threshold behavior depending on the nature of the unfolded behaviors—despite what participants said beforehand. That is, there are reliable violations between people's self-set thresholds vs. the thresholds they act on. For example, imagine participants self-set a judgment threshold of 5 cheating behaviors. It was found that these participants passed negative judgment on the target when they only cheated 4 times—which falls short of their threshold of 5, and thus should *not* have spurred them to pass judgment—if those 4 occurrences ended up being especially egregious. Klein and O'Brien situated these effects in Support Theory, which posits that people weight the evidential value of information based on its personal salience (Tversky & Koehler, 1994). At Time 1, for example: Even though participants could have imagined 4 especially egregious cheating behaviors beforehand (as they were instructed to consider when first predicting their threshold), they could have *also* imagined any number of other possible combinations at this stage (that they were *also* instructed to consider)—thus diluting the salience of the specific especially-egregious case. Yet at Time 2, participants experience the one specific reality that actually unfolds right in front of them, which by definition is highly salient. Thus, if the specific especially-egregious case happens to unfold, people respond to that to a stronger degree than the degree to which they claimed they would beforehand, at which point such a case

was less salient. Klein and O'Brien documented these violations across consequential behavioral thresholds in addition to those involving dispositional judgment; for example, a parent might set a punishment rule for their children of "3 strikes and you're out," or a manager might set a reward rule for their employees of "Make 10 sales and you'll get a bonus"—but they too violate these objective and external thresholds depending on unfolded support (and despite said parents and managers being informed to imagine all such possibilities beforehand).

III. New Questions and Future Directions Inspired By The Top-Down Approach

Finally, to end this chapter, it is worth discussing new questions and future directions that follow from approaching the topic of change thresholds as a top-down (vs. bottom-up) process. Surely, both kinds of approaches—top-down *and* bottom-up—influence whether, when, and why people cross change thresholds. Nonetheless, I argue that there are unique advantages to the top-down approach in terms of generating new avenues for research. As I have discussed throughout, the top-down approach can uniquely accommodate how people experience and judge change with richer and more ambiguous social domains that may lack objective thresholds. Expanding on this idea, I end by highlighting three especially exciting avenues.

Comparing objective thresholds to subjective thresholds

First, there is interesting research to be done simply comparing objective thresholds for change to people's subjective crossing (or not crossing) of those thresholds. Take, for instance, the external examples that opened this chapter: One could test when and why people judge a 17-year-old as adult or a 19-year old as a child, despite both violating the "objective" threshold for adulthood at 18 years (at least in the United States); one could test when and why people judge a person with a 100.3° Fahrenheit temperature as sick or a person with a 100.5° Fahrenheit temperature as healthy, despite both violating the "objective" threshold for fever at 100.4°

Fahrenheit; one could test when and why people judge climate change as irreversible at 1.5° Celsius or as reversible at 1.6° or 1.4° Celsius, despite both violating the "objective" threshold for disaster at 1.5° Celsius; and so forth.

Any number of psychological factors might foster potential discrepancies between people's subjective judgments of threshold-crossings as compared to when such thresholds should be crossed according to some externally-established standard. For example, basic principles of motivated reasoning (which posit that people evaluate themselves in a more positive light as compared to how they evaluate others: e.g., Kunda, 1990) might predict that people will be quicker to cross favorable thresholds and slower to cross unfavorable thresholds when judging change in themselves vs. others. As applied to the above examples, people might (for instance) be especially quick to conclude that they "must still be okay" even after their temperature crosses 100.4° Fahrenheit (whereas they more accurately adhere to the 100.4° cutoff when giving health advice to *others*). At the same time, other psychological motivations might interact with such effects (e.g., perhaps people are especially quick to include that they "must be ill" for purposes of risk prevention and early detection). Either way, note that the key point here is that "third variables" might affect threshold discrepancies, and more research is needed to understand these variables.

Note also how such an approach would advance the literature on change judgment by helping to theoretically unpack where people's priors for change come from in the first place (and what those priors are), beyond simply modeling inherent future uncertainty. This approach can uniquely assess how people judge change when change is known and coming, and their attention is fully paid to each stage (e.g., how people diagnose "official" change in a romantic spark response to evaluating the quality of a full range of past and present dates, as opposed to

awaiting yet-unknown qualities of future dates)—all as a function of applying the insights that

have been discovered (e.g., perhaps people are prone to drawing quicker thresholds for romantic

decline vs. romantic improvement, holding other evidence for change constant). As tested in the

context of comparing objective thresholds to subjective thresholds, one can therefore better

understand when and why people judge change (in)accurately or "accuracy" may even become

irrelevant in this context.

Assessing tipping points and other degrees of inflection

Second, future research could more granularly map out different points of change that

speak to people's change thresholds. For example, in O'Brien and colleagues' initial research on

thresholds, they conceptualized such judgments as "tipping point" judgments—the very first

points at which people believe they have seen enough evidence for change to conclude that

change must be occurring (e.g., e.g., O'Brien & Klein, 2017; O'Brien, 2020). But people's

judgments of the "very first point" of change might be different from when they fully and finally

cross a change threshold—which might be better captured by the "very last point" they are

certain change has occurred, or somewhere in the middle, or another point(s) altogether. Degrees

of change especially influence people's judgments within improvement (vs. decline) contexts

(O'Brien, 2022).

Wixted (2020, p. 202) also noted a similar issue in the context of existing psychophysics

research on the just-noticeable difference (what Wixted refers to as "JND" below):

> Although rarely discussed, the concept of the JND is a moving target. Imagine running
> different groups of blindfolded participants and asking them to indicate when they notice
> a change in heaviness as water is slowly added to a 100-gm cup held in one's hand. For
> one group, the instructions might stipulate that they should declare a noticed change only
> when they are 100% certain that it has occurred. The JND for this group might be 10 gm.
> For a second group, everything is the same except that they are asked to declare a noticed
> change when they are at least 50% certain that it has occurred. The average JND for this
> group might be lower, perhaps only 5 gm. Still a third group is asked to declare a noticed

change when they are only 10% certain that it has occurred. For this group, the JND might turn out to be even lower (e.g., 1 gm). The point is that there is no single JND for a given intensity because it becomes ever smaller as the confidence required to detect a change decreases.

This question of how different degrees of change might differentially influence people's passing of change thresholds remains unanswered, but future research should work to answer it—because such insights would bear on better understanding and predicting consequential behavior change (e.g., when and why particular groups "officially" revolt or concede, or when and why particular individuals "officially" start vs. stop goal pursuit).

Understanding how people judge change across generational and societal time

Finally, future psychological research on change thresholds could continue to expand to other important domains of change judgment—such as testing the thresholds that people draw for judging "official" changes between generational cohorts (e.g., what, exactly, marks the dividing line between Gen-Z cohorts vs. Millennial cohorts vs. Gen-X cohorts, and so forth?: e.g., Konrath et al., 2014; Konrath et al., 2011) and the thresholds that people draw for judging "official" changes over time in acceptable vs. unacceptable social behavior and shifting societal norms (e.g., what, exactly, marks the dividing line between past bad actors who "should have known better" and hence should be "cancelled" in the present, as compared to past bad actors who "could not have known better" and hence are immune to "cancellation" in the present?: e.g., Ronson, 2016).

Indeed, more generally, people often popularly discuss and debate the points at which things change in high stakes, policy-relevant contexts—from understanding the point at which a fetus "officially" becomes a human deserving of human rights, to understanding the point at which an adult's stereotype-defying identity "officially" becomes accepted (or denied) by others. Yet, despite the pervasiveness and obvious practical importance of such judgments, there seems

to be surprisingly little research on them. One could fruitfully adopt currently-known principles of how people cross change thresholds (e.g., the negativity biases reviewed earlier) to make predictions about these domains as well (e.g., the extent to which the judge in question views the given issue as a negative [vs. positive] one may predict faster [vs. slower] threshold judgments).

Concluding Thoughts

Everyone knows that things change—yet there is presumably less agreement about the precise point at which they do. The goal of this chapter was to provide a framework for establishing and understanding such disagreements: People's crossing of change thresholds might often be better understood as a top-down process that occurs "inside their own heads" as opposed to a bottom-up process that occurs "truly out there." Understanding change thresholds as a top-down (vs. bottom-up) process represents a promising perspective for future research across psychological science.

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References

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Adams, G. S., Converse, B. A., Hales, A. H., & Klotz, L. E. (2021). People systematically overlook subtractive changes. *Nature*, *592*, 258-261.

Aengenheyster, M., Feng, Q. Y., van der Ploeg, F., & Dijkstra, H. A. (2018). The point of no return for climate action: Effects of climate uncertainty and risk tolerance. *Earth System Dynamics*, *9*, 1085-1095.

Agostinelli, G., Sherman, S. J., Fazio, R. H., & Hearst, E. S. (1986). Detecting and identifying change: Additions versus deletions. *Journal of Experimental Psychology: Human Perception and Performance*, *12*, 445-454.

Baron, M. E. (1969). *The origins of infinitesimal calculus*. London, UK: Pergamon Press.

Beck, D. M., Rees, G., Frith, C. D., & Lavie, N. (2001). Neural correlates of change detection
        and change blindness. *Nature Neuroscience*, *4*, 645-650.

Campbell, T., O'Brien, E., Van Boven, L., Schwarz, N., & Ubel, P. A. (2014). Too much
        experience: A desensitization bias in emotional perspective taking. *Journal of Personality
        and Social Psychology*, *106*, 272-285.

Carlson, K. A., & Shu, S. B. (2007). The rule of three: How the third event signals the
        emergence of a streak. *Organizational Behavior and Human Decision Processes*, *104*,
        113-121.

Chabris, C., & Simons, D. (2010). *The invisible gorilla and other ways our intuitions deceive us*.
        New York, NY: Crown.

Chang, H. (2008). The myth of the boiling point. *Science Progress*, *91*, 219-240.

Conway, M., & Ross, M. (1984). Getting what you want by revising what you had. *Journal of
        Personality and Social Psychology*, *47*, 738-748.

Demany, L., Trost, W., Serman, M., & Semal, C. (2008). Auditory change detection: Simple
        sounds are not memorized better than complex sounds. *Psychological Science*, *19*, 85-91.

Eibach, R. P., Libby, L. K., & Gilovich, T. D. (2003). When change in the self is mistaken for
        change in the world. *Journal of Personality and Social Psychology*, *84*, 917-931.

Engen, T. (1971). Psychophysics, I: Discrimination and detection, and II: Scaling. In J. W. Kling
        & L. A. Riggs (Eds.), *Woodworth and Schlosberg's experimental psychology*. New York,
        NY: Holt, Rinehart and Winston.

Fisher, P. (2000). Sorites paradox and vague geographies. *Fuzzy Sets and Systems*, *113*, 7-18.

Garner, J. S., Jarvis, W. R., Emori, T. G., Horan. T. C., & Hughes, J. M. (1988). CDC definitions
        for nosocomial infections, 1988. *American Journal of Infection Control*, *16*, 128-140.

Gawronski, B., & Bodenhausen, G. V. (2006). Associative and propositional processes in evaluation: An integrative review of implicit and explicit attitude change. *Psychological Bulletin*, *132*, 692-731.

Green, D. M., & Swets, J. A. (1966). *Signal detection theory and psychophysics*. New York, NY: Wiley.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, *74*, 1464-1480.

Gregg, A. P., Seibt, B., & Banaji, M. R. (2006). Easier done than undone: Asymmetry in the malleability of implicit preferences. *Journal of Personality and Social Psychology*, *90*, 1-20.

Grimes, J. (1996). On the failure to detect changes in scenes across saccades. In K. Akins (Ed.), *Vancouver studies in cognitive science, Vol. 2: Perception* (pp. 89-110). New York, NY: Oxford University Press.

Hamilton, V. E. (2016). Adulthood in law and culture. *Tulane Law Review*, *91*, 55-97.

Heraclitus. (translated by D. W. Graham, 2015). From *The Stanford encyclopedia of philosophy*. Retrieved from http://plato.stanford.edu/ archives/fall2015/entries/heraclitus/

Ji, L. J., Nisbett, R. E., & Su, Y. (2001). Culture, change, and prediction. *Psychological Science*, *12*, 450-456.

Kardas, M., & O'Brien, E. (2018). Easier seen than done: Merely watching others perform can foster an illusion of skill acquisition. *Psychological Science*, *29*, 521-536.

Kellen, D., & Klauer, K. C. (2018). Elementary signal detection and threshold theory. In

    Wagenmakers, E. J. (Ed.), *Stevens' handbook of experimental psychology and cognitive*

    neuroscience (pp. 1-39). New York, NY: John Wiley & Songs, Inc.

Kim, M., Park, B., & Young, L. (2020). The psychology of motivated versus rational impression

    updating. *Trends in Cognitive Sciences*, *24*, 101-111.

Klein, N., & O'Brien, E. (2016). The tipping point of moral change: When do good and bad acts

    make good and bad actors? *Social Cognition*, *34*, 149-166.

Klein, N., & O'Brien, E. (2017). The power and limits of personal change: When a bad past does

    (and does not) inspire in the present. *Journal of Personality and Social Psychology*, *113*,

    210-229.

Klein, N., & O'Brien, E. (2018). People use less information than they think to make up their

    minds. *Proceedings of the National Academy of Sciences*, *115*, 13222-13227.

Klein, N., & O'Brien, E. (2022). Threshold violations in social judgment. Manuscript under

    review.

Konrath, S., Chopik, W. J., Hsing, C., & O'Brien, E. (2014). Changes in adult attachment styles

    in American college students over time: A meta-analysis. *Personality and Social*

    Psychology Review, *18*, 326-248.

Konrath, S., O'Brien, E., & Hsing, C. (2011). Changes in dispositional empathy in American

    college students over time: A meta-analysis. *Personality and Social Psychology Review*,

    15, 180-198.

Kristal, A. C., O'Brien, E., & Caruso, E. M. (2019). Yesterday's news: A temporal discontinuity

    in the sting of inferiority. *Psychological Science*, *30*, 643-656.

Kunda, Z. (1990). The case for motivated reasoning. *Psychological Bullletin*, *108*, 480-498.

Levari, D. E., Gilbert, D. T., Wilson, T. D., Amodio, D. M., & Wheatley, T. (2018). Prevalence-induced concept change in human judgment. *Science*, *360*, 1465-1467.

Levine, M., & Shefner, J. (1981). *Fundamentals of sensation and perception*. Reading, MA: Addison Wesley.

Mann, T. C., & Ferguson, M. J. (2015). Can we undo our first impressions? The role of reinterpretation in reversing implicit evaluations. *Journal of Personality and Social Psychology*, *108*, 823-849.

Massey, C., & Wu, G. (2005). Detecting regime shifts: The causes of under- and overreaction. *Management Science*, *51*, 932-947.

O'Brien, E. (2013). Easy to retrieve but hard to believe: Metacognitive discounting of the unpleasantly possible. *Psychological Science*, *24*, 844-851.

O'Brien, E. (2015a). Mapping out past versus future minds: The perceived trajectory of rationality versus emotionality over time. *Journal of Experimental Psychology: General*, *144*, 624-628.

O'Brien, E. (2015b). Feeling connected to younger versus older selves: The asymmetric impact of life stage orientation. *Cognition and Emotion*, *29*, 678-686.

O'Brien, E. (2019). Enjoy it again: Repeat experiences are less repetitive than people think. *Journal of Personality and Social Psychology*, *116*, 519-540.

O'Brien, E. (2020). When small signs of change add up: The psychology of tipping points. *Current Directions in Psychological Science*, *29*, 55-62.

O'Brien, E. (2021). A mind stretched: The psychology of repeat consumption. *Consumer Psychology Review*, *4*, 42-58.

O'Brien, E. (2022). Losing sight of piecemeal progress: People lump and dismiss improvement efforts that fall short of categorical change—despite improving. *Psychological Science*, *33*, 1278-1299.

O'Brien, E., Ellsworth, P. C., & Schwarz, N. (2012). Today's misery and yesterday's happiness: Differential effects of current life-events on perceptions of past wellbeing. *Journal of Experimental Social Psychology*, *48*, 968-972.

O'Brien, E., & Kardas, M. (2016). The implicit meaning of (my) change. *Journal of Personality and Social Psychology*, *111*, 882-894.

O'Brien, E., & Klein, N. (2017). The tipping point of perceived change: Asymmetric thresholds in diagnosing improvement versus decline. *Journal of Personality and Social Psychology*, *112*, 161-185.

O'Brien, E., Kristal, A. C., Ellsworth, P. C., & Schwarz, N. (2018). (Mis)imagining the good life and the bad life: Envy and pity as a function of the focusing illusion. *Journal of Experimental Social Psychology*, *75*, 41-53.

O'Brien, E., & Roney, E. (2017). Worth the wait? Leisure can be just as enjoyable with work left undone. *Psychological Science*, *28*, 1000-1015.

O'Brien, E., & Smith, R. W. (2019). Unconventional consumption methods and enjoying things consumed: Recapturing the "first time" experience. *Personality and Social Psychology Bulletin*, *45*, 67-80.

Pashler, H. (1988). Familiarity and visual change detection. *Perception & Psychophysics*, *44*, 369-378.

Pastore, R. E., & Scheirer, C. J. (1974). Signal detection theory: Considerations for general application. *Psychological Bulletin*, *81*, 945-958.

Quoidbach, J., Gilbert, D. T., & Wilson, T. D. (2013). The end of history illusion. *Science*, *339*, 96-98.

Rensink, R. A. (2002). Change detection. *Annual Review of Psychology*, *53*, 245-277.

Ronson, J. (2016). *So you've been publicly shamed*. London, UK: Picador.

Ross, M. (1989). Relation of implicit theories to the construction of personal histories. *Psychological Review*, *96*, 341-357.

Rotello, C. M. (2017). Signal detection theories of recognition memory. In J. H. Byrne & J. T. Wixted (Eds.), *Learning and memory: A comprehensive reference* (pp. 201-226). Oxford, UK: Elsevier.

Schwarz, N. (2002). Situated cognition and the wisdom of feelings: Cognitive tuning. In L. Feldman Barrett & P. Salovey (Eds.), *The wisdom of feelings* (pp. 144-166). New York, NY: Guilford.

Schwarz, N. (2007). Attitude construction: Evaluation in context. *Social Cognition*, *25*, 638-656.

Shu, S. B., & Carlson, K. A. (2014). When three charms but four alarms: Identifying the optimal number of claims in persuasion settings. *Journal of Marketing*, *78*, 127-139.

Simons, D. J., & Ambinder, M. S. (2005). Change blindness: Theory and consequences. *Current Directions in Psychological Science*, *14*, 44-48.

Simons, D. J., Franconeri, S. L., & Reimer, R. L. (2000). Change blindness in the absence of a visual disruption. *Perception*, *29*, 1143-1154.

Skowronski, J. J., & Carlston, D. E. (1987). Social judgment and social memory: The role of cue diagnosticity in negativity, positivity, and extremity biases. *Journal of Personality and Social Psychology*, *52*, 689-699.

Skowronski, J. J., & Carlston, D. E. (1989). Negativity and extremity biases in impression

formation: A review of explanations. *Psychological Bulletin*, *105*, 131-142.

Staley, D. J. (2002). A history of the future. *History and Theory*, *41*, 72-89.

Tversky, A., & Koehler, D. J. (1994). Support theory: A nonextensional representation of

subjective probability. *Psychological Review*, *101*, 547-567.

Tyler, T. R., & Boeckmann, R. J. (1997). Three strikes and you are out, but why? The

psychology of public support for punishing rule breakers. *Law & Society Review*, *31*,

237-266.

Uslay, C., Altintig, Z. A., & Winsor, R. D. (2010). An empirical examination of the "rule of

three": Strategy implications for top management, marketers, and investors. *Journal of

Marketing*, *74*, 20-39.

Wilken, P., & Ma, W. J. (2004). A detection theory account of change detection. *Journal of

Vision*, *4*, 1120-1135.

Wilson, A. E., & Ross, N. (2001). From chump to champ: People's appraisals of their earlier and

present selves. *Journal of Personality and Social Psychology*, *80*, 572-584.

Wixted, J. T. (2020). The forgotten history of signal detection theory. *Journal of Experimental

Psychology: Learning, Memory, and Cognition*, *46*, 201-233.