**Abstract**

In this paper we introduce the *shared features principle* which refers to the idea that, when two stimuli share one feature, people often assume that they share others features as well. This principle can be recognized in several known psychological phenomena, most of which were until now never considered to be related in this way. To illustrate the generative power of the principle, we report eight pre-registered studies (*n* = 1609) in which participants completed an acquisition phase containing three stimuli: a neutral target, a positive source, and a negative source. Our results indicate that behavioral intentions, implicit evaluations, and explicit evaluations of a target object were influenced by the source object with which the target shared a feature. Taken together, the shared features principle appears to be general, reliable, and replicable across a range of measures in the attitude domain. We close with a discussion of its theoretical implications, relevance to many areas of psychological science, as well as its heuristic and predictive value.

*Keywords*: Shared Features, Principle, Attitudes, Implicit, Learning

The Shared Features Principle: If Two Objects Share a Feature, People Assume Those Objects Also Share Other Features

Scientific principles are valuable because they highlight commonalities amongst many different empirical phenomena. In doing so, they not only create order and offer insight (i.e., their heuristic function) but also point us towards new and previously undiscovered instances of that principle (i.e., their predictive function). In this paper, we introduce a new principle to the realm of psychology. This principle, which we refer to as the *shared features principle*, postulates that when stimuli share one feature, people will assume that those stimuli share other features as well. We first provide an overview of existing phenomena in which the shared features principle can be recognized. We then consider the principle itself in more detail by relating it to concepts that can be applied to a wide variety of phenomena. Finally, we illustrate the predictive value of the principle by demonstrating a novel instantiation that controls for alternative factors.

Let us first consider existing phenomena that represent instances of the shared features principle. Take the minimal group effect in social psychology (Otten, 2016; Tajfel, Billig, Bundy, & Flament, 1971). Research shows that when individuals are arbitrarily assigned to the same group based on some shared feature (e.g., similar clothing item or preference for certain paintings), people assume that those individuals share other features as well (e.g., that others will share the participant’s own traits; van Veelen, Otten, Cadinu, & Hansen, 2016). In the context of stigmatization, the mere proximity effect shows that when a stigmatized and non-stigmatized person share a similar physical location to one another, people assume that they also share other features (e.g., a normal weight individual will be stigmatized more when they stand next to an overweight individual; Hebl & Mannix, 2003).

In consumer and marketing psychology, research on counterfeit brands shows that these brands intentionally imitate the physical properties of (and thus share features with) high status brands in the hope this will influence assumptions about, and ultimately consumption of, the fake brand itself (e.g., assumptions that it is also high in quality, status, and worth purchasing; Phau & Teah, 2009). In moral psychology, when one person (John) is accountable for his past actions (e.g., membership of the Nazi party) and is said to share a feature with a second person (Tom) (e.g., John and Tom are part of the same family), this shared feature influences the assumptions people make about the latter’s moral accountability (e.g., they assume that Tom is also morally responsible for his family member’s actions; Uhlmann, Zhu, Pizarro, & Bloom, 2012). Finally, the shared features principle can also be recognized in learning psychology. In evaluative conditioning (EC), for instance, the fact that a neutral stimulus shares a similar time and location with a valenced stimulus often leads the former to acquire properties of the latter (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010). This is also true for attribute conditioning: when an unknown person and a known athlete share one feature (spatio-temporal properties), people assume that they also share other features as well (the CS is viewed as being more athletic or healthy: Förderer & Unkelbach, 2015).

If we take a step back, set the specific stimuli and responses to the side, and search for commonalities between the above, then we see that each phenomenon involves a broadly similar situation: one where people make assumptions about the properties of one stimulus (e.g., how positive or negative a person, group, or brand product is) based on the fact that it shares some other feature (e.g., physical or spatio-temporal properties) with a second stimulus (another person, group, or brand product).

If we are correct, then there are remarkable similarities between seemingly different domains in psychological science, which offers many new opportunity for cross-fertilization. Today the aforementioned effects are typically studied in isolation, with different researchers busy documenting the moderators and mediators of the behaviors they are interested in, and rarely interacting with their colleagues (or drawing on findings) from other intellectual domains. This does not have to be the case. In addition to illuminating previously hidden similarities and differences between psychological phenomena (heuristic value), the shared features principle also opens up entirely new avenues for study (predictive value). Before unpacking its heuristic and predictive value, we will first specify the principle itself. We will do so by drawing on a recently developed conceptual framework that centers on the idea of feature transformation (De Houwer, Richetin, Hughes, & Perugini, 2019).

**Feature Transformation**

Because the shared features principle applies to a wide range of known, and still to-be-discovered empirical phenomena, it is best described in abstract terms that do not refer to a specific phenomenon. De Houwer et al. (2019) recently introduced a framework that may prove useful in this regard. Their framework consists of four abstract concepts: source features, target features, source objects, and target objects. According to this perspective, ‘objects’ are broadly defined as any potential stimulus or behavior: they can refer to people, animals, inanimate items, and even responses. Features are defined as any assumed state of an object. These states can have multiple values and can relate to many different properties, from physical (e.g., height), and psychological (e.g., intelligence, valence), to behavioral (e.g., the way in which an object responds to its environment; also see Tversky, 1977).

The shared features principle is concerned with two types of features: *source features* and *target features*. [[1]](#footnote-1) Target features are those features of an object about which assumptions are being made. Source features are those features of an object which give rise to assumptions about target features. The object that possesses the target feature is called the target object whereas the object that possesses the source feature is called the source object.

The target feature is typically the dependent variable whereas the source feature is the independent variable under investigation. The value of a source feature can be varied in order to investigate if this influences the corresponding value of the target feature. To illustrate this more clearly, take the halo effect. Here features of the source object (e.g., how attractive a person is) lead people to make assumptions about features of a target object (e.g., how intelligent that person is). The source and target feature can belong to the same object (e.g., judging how intelligent an attractive person is) or to different objects (e.g., judging how intelligent the partner of an attractive person is; see Forgas & Laham, 2016, for a review). In studies on the halo effect, the value of a source feature (perceived attractiveness) is varied to investigate if this influences the value of a target feature (perceived intelligence).

When a feature of a source object influences the assumptions made about a feature of a target object, *feature transformation* is said to take place. The term ‘transformation’ highlights that a source feature can give rise to assumptions about the features of a target object, and that the latter can change in ways that are similar or different to the former. To illustrate, let’s return to the halo effect wherein features of a source object (e.g., how attractive a person is) influence assumptions about target object features (e.g., how intelligent a person is). It may be that an assimilative halo effect emerges for men (attractive males are thought to be competent in most job hiring situations) whereas contrast effects emerge for women (attractive females are thought to be less competent in certain job hiring situations; see the ‘beauty is beastly effect’; Paustian-Underdahl, & Walker, 2016). The term transformation captures both possibilities.

**The Shared Features Principle**

The shared features principle tells us why a wide variety of feature transformation effects occur: it implies that when source and target objects *share* some feature with one another people will make assumptions about other features of the target object. Verifying that two objects share a feature involves the identification of a feature that is part of both objects (also see Tversky, 1977). For instance, in minimal group effects, source and target objects both independently possess a common feature (e.g., the color of the clothing that they wear). [[2]](#footnote-2)

The shared features principle is grounded in the phenomenon of generalization (see Ghirlanda & Enquist, 2003). Broadly speaking, generalization refers to the transfer of properties from one stimulus to another when those stimuli are similar along some dimension. The shared features principle implies that one can vary similarity by manipulating the features of objects (see Tversky, 1977, for a justification of this assumption) and builds on recent research showing that generalization is not limited to similarity with regard to perceptual features but also encompasses similarity at the symbolic level (Hughes et al., 2018). It also extends beyond simple generalization by allowing for a transformation of features (and not merely a transfer of features) to take place from one stimulus to another.

Finally, just like any scientific principle, the shared features principle does not *always* hold but does so only under certain conditions (e.g., it is likely that the shared feature needs to be salient). In fact, one of the aims of research is to uncover the moderators of scientific principles. Like all functional scientific principles (e.g., gravity), the principle does not specify the mechanism by which instances of the principle are brought about, nor does it assume that the same mechanism mediates all instances of the principle. Although we will speculate about the mechanism underlying the shared features principles at the end of our paper, the main aim of the paper is to introduce the principle itself and illustrate its heuristic and predictive value.

**Heuristic Value**. The shared features principle has considerable heuristic value. As illustrated above, it can be applied to a wide variety of existing phenomena that were never previously viewed as being connected (e.g., it highlights commonalities and differences between effects in person perception and counterfeit branding). The unifying nature of the principle can be further strengthened by using the terms of the feature transformation framework. Until now, the social, persuasion, marketing, moral, and learning psychology literatures each adopted different terms when describing instances of the shared features principle. As a result, there is currently a multiplicity of concepts that can undermine our ability to ‘see the forest through the trees’ (i.e., to identify what is genuinely similar or different between various types of shared feature effects). For instance, evaluative and attribute conditioning research refers to conditioned (CS) and unconditioned stimuli (US), whereas operant conditioning research refers to discriminative stimuli (Sd) and reinforcers (Sr). These terms are rarely used in research on marketing, halo, moral accountability, and person perception. Rather these domains employ idiosyncratic terms that typically refer to the specific properties of the features and objects being studied (e.g., the status of products).

The feature transformation framework in general, and shared features principle in particular, circumvent this issue by providing a common or ‘universal’ language that allows one to describe and functionally explain many phenomena using a limited set of terms. Concepts such as source/target and object/feature can be used to describe shared feature effects that are typically studied (under different names) in different domains. For example, in impression formation research, we can refer to the fact that a source object (Bob) possesses a certain feature (e.g., is violent). When people then learn that a target object (Mike) shares some other feature with the source (e.g., they have physical characteristics in common), we can say that this shared feature leads people to make assumptions about the target object’s features (e.g., that Mike is also violent). The same concepts can also be applied to conditioning research. Here too people learn that a source object (US) possesses a certain feature (e.g., is valenced as in EC or athletic as in attribute conditioning). They then learn that a target object (CS) shares some other feature with the source (e.g., both are presented together in space and time). As a result, people make assumptions about the target object’s features (that the CS is also valenced or athletic). The very same concepts can be used when dealing with different types of learning, stigmatizing, prejudice, branding, and so on.

In short, the shared features principle allows researchers to conceptualize and speak about effects in ways that (a) enhance communication within and between intellectual domains, (b) prevent fragmentation, confusion, or conflict resulting from the use of multiple terms to describe the same underlying phenomenon, and (c) reveals similarities and differences between phenomena. While acknowledging important differences between domains, it argues that many effects involve four basic elements (source object, target object, source feature, and target feature), a situation wherein the source and target share one feature, and as a result, new assumptions are made about other target object features.

**Predictive Value**. The shared features principle also has predictive value and allows us to view old phenomena in new ways. Take EC, for instance, which is typically defined as a change in liking due to stimulus pairings. Most researchers would argue that EC effects are driven by the fact that CS and US are presented in spatio-temporal contiguity. Yet our account takes a different perspective. It argues that EC effects may actually be due to the fact that the CS and US *share* a feature with one another, and in EC studies, this shared feature just so happens to be the time and location at which they are presented. If correct, then the crucial element in EC is the fact that stimuli share a feature and not the mere fact that they are paired in space and time. Note that this new way of thinking does not draw EC effects into question – simply our prior explanation of the observed changes in liking. In other words, we are not questioning that stimulus pairings can lead to changes in liking. Rather we are re-conceptualizing stimulus pairings as just one way to induce a shared feature effect. This new perspective leads to the prediction that EC-like effects can also be found when stimuli share a feature other than their spatio-temporal presence (e.g., the color in which stimuli are presented). Verifying this prediction would support the idea that EC is just one instance of a much broader class of share features effects and would illustrate the predictive power of the shared features principle.

**The Current Research**

With the above in mind we carried out eight studies. Each employed a broadly similar format which we will preview here. We first asked participants to complete an acquisition phase. During this phase a series of trials were presented wherein three stimuli simultaneously appeared onscreen: a positive source object, a negative source object, and a neutral target object. We then manipulated the extent to which the target object shared a feature with a certain source object. In Experiments 1-3 the shared feature was the color in which stimuli were presented: half of the trials presented the neutral target object in the same color as the positive source whereas the other half presented the neutral target object in the same color as the negative source object. In Experiment 4 the shared feature was the size of the stimuli: half of the trials presented the neutral target object in the same size as a positive source whereas the other half presented the target object in the same size as a negative source. In Experiment 5 the shared feature was conceptual in nature. We first trained a class of conceptually related color stimuli (*Blue-Same-Yellow* and *Green-Same-Purple*) and then, during the acquisition phase, presented a neutral target object in either blue or green, along with a positive source in yellow and a negative source in purple. Experiments 6-8 excluded alternative explanations for this effect, replicated our prior findings with yet another implicit measure (evaluative priming), and extended our findings into a socially relevant domain (person perception).

Following the acquisition phase, we assessed for attitude formation (target object evaluations) using self-report ratings and an implicit measure (either the Implicit Association Test [IAT] or evaluative priming). We added these latter measures as they are assumed to reflect more automatic evaluations that can influence subsequent behavior in unique ways (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). If changes in liking are driven by mere spatio-temporal contiguity then we would expect to see similar and ambivalent evaluative responses towards both target objects (given that they were both repeatedly paired with positive *and* negative source objects). Yet if those same effects are driven by the fact that the target and source share another feature (e.g., color, size, location) then we would expect to observe positive evaluations of one and negative of the other. If our account is correct, changes in liking should be moderated by a range of different features that are shared by stimuli.

**Experiment 1**

**Method**

**Participants and design**. A total of 114 English-speaking volunteers (62 females; *Mage* = 33.12, *SD* = 8.39) participated online via the Prolific Academic website (https://prolific.ac) in exchange for a monetary reward (€1.50). The experiment was programmed in Inquisit 4.0 and hosted via Inquisit Web (Millisecond Software, Seattle, WA). It involved a single-factor between-subjects design (*Shared Feature*: target shared color with positive vs. negative source object), with self-reported ratings and IAT effects as the main dependent variables. Three method variables were manipulated between participants: *evaluative task order* (self-reports vs. IAT first), *IAT block order* (learning [acquisition] phase consistent vs. inconsistent first) and *stimulus assignment* (which target object appeared in the same color as positive or negative source objects). The sample size was determined prior to data collection on the basis of a power analysis. We stopped data-collection when 114 participants had completed all measures of the experiment to ensure that we would have sufficient statistical power to detect medium effects (planned sample size after exclusions = 110 which gives power = 0.80 to find an effect size of *d* = 0.47 at alpha = 0.05, two-tailed; or power = 0.95 to find an effect size of *d* = .63). Note that a similar analytic strategy was used in Experiments 1-8 and planned sample sizes were therefore similar (excepted where noted). The study designs were pre-registered, and are available, along with the raw data, and analytic plans for this and all other experiments on the Open Science Framework website (https://osf.io/pqm9v/). We report all manipulations, measures, and studies run. All data were collected without intermittent data analysis.

**Materials**

**Stimuli**. Two nonsense words (Morag and Struan) served as the target objects (TO). Six positive (*rainbow, pleasure, smile, love, paradise, joy*) and six negative adjectives (*war, cancer, hate, hell, misery, vomit*) served as the positive and negative source objects (SO).

**IAT**. The two nonsense words served as one set of target stimuli and the words “Good” and “Bad” as another. Eight positively valenced and eight negatively valenced adjectives served as one set of attribute stimuli (*fantastic, great, nice, good, pleasant, wonderful, amazing, happy versus terrible, disgusting, nasty, horrible, sick, awful, sad, unpleasant*) and the two nonsense words served as the second set.

**Procedure**

Participants were first provided with a general overview of the experiment and then asked for their informed consent. The study consisted of three phases: acquisition phase, evaluative measures, and exploratory questions.

**Acquisition phase**. The acquisition phase consisted of three blocks of 16 trials (48 total), with each block containing two types of trials: one trial in which Target Object 1 [TO1] was eventually presented in the same color as positive source objects, and another trial in which Target Object 2 [TO2] was eventually presented in the same color as negative source objects. Specifically, three stimuli simultaneously occurred onscreen during each trial: a neutral target object (either Morag [TO1] or Struan [TO2]) along with a positive and negatively valenced adjective (positive and negative source object [SO]). All three stimuli were initially presented in white against a black background for 3000ms. On certain trials, TO1 and the positive SO both changed to the same color (e.g., blue) whereas the negative SO changed to a different color (e.g., green). On other trials, TO2 and the negative SO both changed to one color (e.g., yellow) whereas the positive SO changed to another (e.g., purple). All stimuli remained onscreen for another 3000ms and were then removed, followed by an inter-trial interval of 1250ms, and the next trial. Stimulus color (i.e., blue, green, yellow and purple) was varied across trials, so that none of the colors could assume any specific positive or negative value (see Figure 1).

**Self-reported ratings**. Self-reported evaluations were assessed using four different semantic differential scales. On each trial, one of the two target objects was presented and participants were asked to indicate their general impression of that stimulus using a scale ranging from -5 to +5 with 0 as a neutral point. The four end-points of the scales were as follows: *Negative-Positive*, *Pleasant-Unpleasant*, *Good-Bad*, *I Like It-I Don’t Like It*. A mean evaluative rating was calculated for each TO by averaging scores from these four scales.

**IAT**. We also looked for a shared features effect on automatic evaluations using the IAT. Participants were informed that a series of words would appear one-by-one in the middle of the screen and that their task was to categorize those items with their respective target (TO1 or TO2) or attribute categories (‘Good’ and ‘Bad’) as quickly and accurately as possible. They were told that the two words they had previously encountered (targets) as well as the words “Good” and “Bad” (attributes) would appear on the upper left and right sides of the screen and that stimuli could be assigned to these categories using either the left (‘E’) or right keys (‘I’). Each trial began with the presentation of a target or attribute stimulus. If the participant categorized the word correctly – by selecting the appropriate key for that block of trials – the stimulus disappeared from the screen and the next trial began. In contrast, an incorrect response resulted in the presentation of a red “X” which remained on-screen until the correct key was pressed. Overall, each participant completed seven blocks of trials. The first block of 20 practice trials required them to sort TO1 and TO2 into their respective categories, with TO1 assigned to the left (‘E’) key and TO2 to the right (‘I’) key. On the second block of 20 practice trials, participants assigned positive words to the “Good” category using the left key and negative words to the “Bad” category using the right key. Blocks 3 and 4 (20 and 40 trials, respectively) involved a combined assignment of target and attribute stimuli to their respective categories. Specifically, participants categorized TO1 and positive words using the left key and TO2 and negative words using the right key. The fifth block of 20 trials reversed the key assignments, with TO2 now assigned to the left key and TO1 to the right key. Finally, the sixth and seventh blocks (20 and 40 trials respectively) required participants to categorize TO1 with negative words and TO2 with positive words.

**Behavioral Intentions.** In addition toautomatic and self-reported evaluations we also assessed if the acquisition phase altered behavior intentions towards the target objects. Participants were presented with two brand products labeled with either TO1 or TO2. They were asked to indicate which of these products they would be willing to try in a supermarket and given the following five options: *I would try Morag*, *I would try Struan*, *I would try Morag and Struan*, *I would try neither*, *I don’t know*.

**Exploratory Questions**. Participants were asked a series of exploratory questions about their *contiguity memory* (i.e., the relationship between the TOs-SOs), *color memory* (i.e., the color match between the TOs and SOs), a *manipulation check* to probe if they wrote down the contingencies during the task, *demand compliance* and *reactance,* as well as *hypothesis* and *influence awareness* questions about the rationale for their self-reported and automatic evaluations.

**Results**

**Analytic Strategy**

A series of Welch’s independent sample *t*-tests (along with Cohen’s *d* effect sizes and their 95% confidence intervals) were carried out on the rating and IAT data to determine whether evaluations of a target object (dependent variables) differed as a function of the features it shared with a source object (i.e., the fact that TO1 shared a feature [i.e., color] with a positive SO, and TO2 shared a feature with a negative SO; independent variable). The behavioral intentions data was analyzed using multi-nominal logistic regression models to assess whether participants were more likely to choose a certain target object on the basis of shared features. An identical analytic strategy was used in Experiments 2-5.

**Data Preparation**

**Exclusions**. We excluded data from eight participants who did not complete the entire session. The data of participants who had IAT error rates above 30% across the entire task or above 40% for any one of the four critical blocks, or who responded faster than 400ms on more than 10% of trials were excluded (*n* = 3). This led to a final sample of 103 participants.

**Self-reported ratings**. Self-reported ratings for TO1 and TO2 were first averaged and then a difference scored was calculated by subtracting scores for TO2 from TO1. Positive values indicate a relative preference for the TO that eventually shared a color with a positive SO over the TO that shared a color with a negative SO. Negative values indicate the opposite.

**IAT**. Following the recommendations of Greenwald, Nosek, and Banaji (2003), response latency data were prepared using the D4 scoring algorithm. The resulting D4 IAT scores reflect the difference in mean response latency between the critical blocks divided by the overall variation in those latencies. The IAT score was calculated so that positive values reflected a relative preference for the target object that eventually shared a color with a positive SO (i.e., TO1) relative to the target object which eventually shared a color with a negative SO (i.e., TO2). Negative values indicated the opposite preference (TO2 more positive than TO1).

**Hypothesis Testing**

**IAT.** IAT scores differed as a function of whether the TO shared its color with a positive SO or negative SO, *t*(98.12) = 6.63, *p* < .001, *d* = 1.31, 95% CI = [0.88, 1.74], BF10 > 105. When TO1 shared a color with a positive SO and TO2 shared a color with a negative SO, participants showed a relative automatic preference for TO1 over TO2 (*M* = 0.37, *SD* = 0.46). When the color contingencies were reversed, participants preferred TO2 over TO1 (*M* = -0.23, *SD* = 0.45).

**Self-reported ratings**. Self-reported ratings also differed as a function of whether the TO shared its color with a positive SO or a negative SO, *t*(98.32) = 8.33, *p* < .001, *d* = 1.65, 95% CI = [1.20, 2.10], BF10 > 106. When TO1 shared a color with a positive SO and TO2 shared a color with a negative SO, participants showed a relative preference for TO1 over TO2 (*M* = 3.33, *SD* = 4.60). When the color contingencies were reversed, participants preferred TO2 over TO1 (*M* = -4.15, *SD* = 4.48).

**Behavioral intentions**. Data from the behavioral intentions question were entered into a multinomial logistic regression with TO1 as the reference category. Only results from the TO1-TO2 comparison are relevant to the shared feature hypothesis and are reported here (i.e., hypotheses do not refer to the selections of neither TO or both TOs). Results demonstrated that participant’s intentions towards TO1 relative to TO2 differed between the two shared feature conditions. The odds that a participant would choose the target object that shared a feature with a positive source object (versus the one that shared a feature with a negative source object) were OR = 13.66, 95% CI = [3.56, 52.44], *p* = .0001.

**Discussion**

Results provide a novel demonstration of the shared features principle in the attitude domain that goes beyond the impact of mere spatio-temporal co-occurrence. Although a neutral target object was repeatedly paired with both positive and negative source objects, it acquired the valence of the source that it shared a feature (color) with it. Specifically, target objects that appeared in the same color as positive sources were rated positively whereas target objects that appeared in the same color as negative sources were rated negatively. We also obtained strong evidence for this shared feature effect on automatic evaluations and behavioral intention measures.

**Experiment 2**

In our second experiment we set out to replicate and extend our initial findings. In Experiment 1, participants completed an acquisition phase during which all stimuli were initially presented in white and only later changed to the same or a different color. In Experiment 2, however, we presented all stimuli in the same color during the first half of the trial. During the second half, we switched the color of one the source objects, while keeping the color of the other source the same as the target object. This modified design allowed us to differentiate between two explanations of our effects. The first (*shared feature hypothesis*) argues that an overlap in some stimulus feature (in this case color) will lead people to indicate that those same stimuli share other properties (valence). If so, then we should expect a similar pattern of findings as obtained in Experiment 1. A second possibility (*salience hypothesis*) entails that people’s attention is fixated on any salient change in the context. Assuming that the effects of spatio-temporal stimulus pairings are magnified when one or both of the events are salient (e.g., Rescorla & Wagner, 1972), one could argue that the change in liking for the target object could have resulted from the mere spatio-temporal pairing of the target object with the salient source object (i.e., the source object whose color changed). This alternative account entails that the observed effect was an instance of EC (i.e., a feature transformation effect due to the sharing of spatio-temporal properties) rather than a feature transformation effect that is due to the sharing of color. If so, then the target should acquire the valence of the source which switches color within the trial (i.e., the salient source stimulus), leading to the opposite effect predicted by the shared features principle.

**Method**

**Participants and design.** 118 participants (67 females; *Mage =* 32.3*, SD =* 8.6) took part in the study via the Prolific Academic website.

**Procedure**

A similar procedure was used as in Experiment 1 with the exception of the acquisition phase.

**Acquisition phase**. Training once again consisted of three blocks of 16 trials (48 total), with each block containing two different types of trials: one in which TO1 stayed the same color as positive words, and another in which TO2 stayed the same color as negative words. Unlike Experiment 1, the TO and two SOs were initially presented in the same color for 3000ms. During one type of trial, TO1 and the positive SO remained in the same color (e.g., blue) whereas the negative SO changed color (e.g., purple). During the second type of trial, TO2 and the negative SO remained in the same color (e.g., yellow) while the positive SO changed color (e.g., green). All stimuli remained onscreen for a further 3000ms before being removed, followed by an inter-trial interval, and the next trial (see Figure 2).

**Results**

**Data Preparation**

We excluded data from 12 participants who did not complete the entire experimental session, and a further three who failed to maintain IAT performance criteria. This led to a final sample of 103 participants.

**Hypothesis Testing**

**IAT**. We found no evidence of differences in IAT scores as a function of the color that a TO shared with a SO, *t*(100.85) = -1.18, *p* = .24, *d* = -0.23, 95% CI = [-0.62, 0.16], BF10 = 0.38. Participants generally showed an automatic evaluation favoring TO2 over TO1 regardless of whether (a) TO1 remained in the same color as positive words and the color of negative words changed (*M* = -0.26, *SD* = 0.54), or (b) TO2 remained in the same color as negative words and the color of positive words changed (*M* = -0.12, *SD* = 0.60).

**Self-reports.** We observed no evidence of differences in self-reported ratings as a function of the color that a TO shared with a SO, *t*(100.98) = -1.09, *p* = .28, *d* = -0.21, 95% CI = [-0.61, 0.18], BF10 = 0.35. Participants generally showed a relative preference for TO2 over TO1 regardless of whether (a) TO1 remained in the same color as the positive SO (*M* = -2.80, *SD* = 5.33) or (b) TO1 remained in the same color as the negative SO (*M* = -1.58, *SD* = 6.03).

**Behavioral intentions**. Data were prepared and analyzed as in Experiment 1. Although participants intentions towards TO1 relative to TO2 differed between the two shared features conditions, they did so in the opposite direction as predicted. The odds that a participant would choose the target object that shared a feature with a positive source object (versus the one that shared a feature with a negative source object) were OR = 0.22, 95% CI = [0.07, 0.66], *p* = .0073.. Participants showed greater behavioral intentions towards TO2 than TO1.

**Discussion**

The findings of Experiment 2 contradicted those obtained in Experiment 1. During the acquisition phase a target and two source objects were first presented in the same color, and then one of the source objects changed to a different color. Participants preferred a target when it shared a color with negative source objects more than when it shared a color with positive sources. Put another way, rather than base their evaluations on a shared feature (i.e., the fact that a source stayed in the same color as the target) participants seemed to have based their evaluations on the source object that changed color during the trial.

**Experiment 3**

The findings reported in Experiment 2 contradict the shared features principle – at least at the aggregated group level. Yet the high degree of variability in evaluative responses, the distribution of evaluations (see Supplementary Materials), as well as responses on the influence awareness question, suggest a more nuanced story. It seems that there may have been different groups of participants in our sample: those that did not show any evaluations towards either TO1 or TO2 (for potentially different reasons), those that showed evaluations in line with the shared features principle (i.e., target acquires the same valence as the SO it shares a color with) and a third group that showed evaluations in line with a salience hypothesis (e.g., target acquires the same valence as the SO which changes color). It appears that this latter group exerted more of an impact on the (overall) group level responses reported in Experiment 2 than the other groups. Responses on the influence awareness question also broadly map onto these different patterns of evaluation.

In retrospect, we believe there may have been a relatively simple explanation for the difference in results of Experiments 1 and 2: the change in task instructions from Experiment 1 to 2. In Experiment 2 participants were told that “you will see two new words: Morag and Struan. These words will appear onscreen together with two other words. The new word (Morag or Struan) and other words will initially appear in one color. Then the color of one of the words will change…Please pay close attention to the color of each word and how they change”. These instructions may have encouraged people to focus greater attention on the change, rather than the overlap, in color, and thus treat changes in color as more diagnostic about target object valence than the shared feature. If so, then modifying task instructions in a way that directs attention to the shared feature may lead to similar effects as seen in Experiment 1. With this in mind, we replicated Experiment 2 while modifying the instructions to emphasize that the target and source objects remained in the same color.

**Method**

**Participants and design.** 118 participants (70 females, *Mage* = 28.19, *SD* = 6.08) took part in the study via the Prolific Academic website.

**Procedure**

An identical procedure was used as in Experiment 2 with the exception of the instructions provided prior to the acquisition phase.

**Acquisition phase**. Prior to training participants were told the following: “You are going to see a new word appear on the screen (i.e., Morag or Struan). Morag or Struan will appear on the left of the screen. Two other words will appear on the right. Morag or Struan and other words will first appear in the same color. Morag or Struan will stay the same color as one of the words on the right. Please pay close attention to the colors of the words. You will be asked some questions about this later on.”

**Results**

**Data Preparation**

Nine participants did not complete the entire session whereas an additional twelve did not meet the IAT criteria. This led to a final sample of 97 participants.

**Hypothesis Testing**

**IAT**. IAT scores differed as a function of the valence of the SO that had the same color as the TO, *t*(93.42) = 3.29, *p* = .001, *d* = 0.66, 95% CI = [0.25, 1.08], BF10 = 20.10. When TO1 remained in the same color as the positive SO (and the color of the negative SO changed) and when TO2 remained in the same color as the negative SO (and the color of the positive SO changed), participants demonstrated a relative preference for TO1 over TO2 (*M* = 0.21, *SD* = 0.46). When the color contingencies were reversed, participants demonstrated a relative preference for TO2 over TO1 (*M* = -0.15, *SD* = 0.59).

**Self-reported ratings.** Self-reported ratings also varied as a function of TO-SO color relation, *t*(92.94) = 5.52, *p* < .001, *d* = 1.13, 95% CI = [0.69, 1.56], BF10 > 104. When TO1 remained in the same color as the positive SO (and the color of the negative SO changed), and when TO2 remained in the same color as the negative SO (and the color of positive SO changed), participants showed a relative preference for TO1 over TO2 (*M* = 2.92, *SD* = 5.25). When the color contingencies were reversed participants demonstrated a relative preference for TO2 over TO1 (*M* = -2.85, *SD* = 5.02).

**Behavioral intentions**. Participants intentions towards TO1 relative to TO2 differed between the two shared features conditions, and in a way that was congruent with prior training. Specifically, the odds that a participant would choose the target object that shared a feature with a positive source object (over the one that shared a feature with a negative source object) were OR = 6.94, 95% CI = [2.03, 23.77], *p* = .002.

**Discussion**

When task instructions directed attention towards (rather than away from) the shared feature, a shared features effect emerged. Specifically, targets that shared a color with positive sources were liked more than targets which shared a color with negative sources. We obtained evidence for the shared features effect on self-report, automatic (IAT), and behavioral intention measures. Importantly, the effect arose even though the TO and SO shared their color from the start of each trial. Unlike the effect that was observed in Experiment 1, the effect in Experiment 3 can therefore not be explained in terms of mere salience.

**Experiment 4**

Until now we have seen how one particular shared feature (color) comes to moderate automatic and self-reported evaluations. Yet our account suggests that other shared features should function in a similar way. Indeed, a common size, direction, location, smell, or taste shared by two stimuli should lead people to act as if those stimuli share other features as well (e.g., valence). Therefore, in order to extend and generalize our findings, we swapped one shared feature (color) for another (size), to demonstrate that this second feature can also moderate likes and dislikes whenever two stimuli share it. In Experiment 4 participants once again encountered an acquisition phase in which three stimuli (neutral target, positive source, negative source) were presented onscreen. This time TO1 and positive sources were presented in the same sized font whereas negative sources were presented in a differently sized font. Likewise, TO2 and negative sources shared a common sized font whereas positive sources were always presented in a different sized font. If we are correct, then targets should acquire the same valence as the sources with which they share a common size.

**Method**

**Participants and design**. 212 participants (103 females, *Mage* = 30.33, *SD* = 6.18) took part in the study via the Prolific Academic website. Given the change in shared feature from color to size (which we thought might be more subtle) we decided to double our planned sample size relative to Experiments 1-3. The same was true for Experiment 5. A sample size of 200 participants provides sufficient power to detect effect sizes of *d* >= 0.4 (power = 0.80 at alpha = 0.05, two-tailed) or *d* = .47 (power = 0.95 at alpha = 0.05, two-tailed).

**Procedure**

A similar procedure was used as in Experiments 1-2 with the exception of the acquisition phase.

**Acquisition phase**. Training consisted of three blocks of 16 trials (48 total) consisting of two different types of trials. During one type of trial TO1 was presented in the same sized font (e.g., 8% of screen height) as positive words and a different sized font as negative words (e.g., 4% of screen height). In another type of trial TO2 is presented in the same sized font as negative words and a different sized font as positive words. Stimuli were always presented in the same color (white) and the sizes of the fonts was randomly counterbalanced across trials (e.g., sometimes a target and source share a small [4%] font and at other times they shared a large [8%] font; see Figure 3).

**Results**

**Data Preparation**

Fifteen participants did not complete the entire session whereas an additional nine did not meet the IAT criteria. This led to a final sample of 187 participants.

**Hypothesis Testing**

**IAT.** IAT scores differed as a function of the valence of a SO that shared a common size with a TO, *t*(184.00) = 5.02, *p* < .001, *d* = 0.73, 95% CI = [0.44, 1.03], BF10 > 104. When TO1 was presented in the same size font as a positive SO and TO2 was presented in the same size font as a negative SO, participants showed a relative automatic preference for TO1 over TO2 (*M* = 0.16, *SD* = 0.48). When the size contingencies were reversed, participants demonstrated a relative preference for TO2 over TO1 (*M* = -0.18, *SD* = 0.46).

**Self-reported ratings**. Self-reported ratings differed as a function of the valence of a SO that shared a common size with a TO, *t*(179.27) = 8.51, *p* < .001, *d* = 1.25, 95% CI = [0.93, 1.59], BF10 > 106. When TO1 was presented in the same sized font as a positive SO, and TO2 was presented in the same sized font as a negative SO, participants showed a relative preference for TO1 over TO2 (*M* = 3.57, *SD* = 4.99). When the size contingencies were reversed, participants showed a relative preference for TO2 over TO1 (*M* = -2.18, *SD* = 4.21).

**Behavioral intentions**. Participant’s intentions towards TO1 relative to TO2 differed between the two shared features conditions, in a way that was congruent with prior training. Specifically, the odds that a participant would choose the target object that shared a feature (size) with a positive source object (over the one that shared a feature with a negative source object) were OR = 7.63, 95% CI = [3.11, 18.76], *p* < .0001.

**Discussion**

Results indicate that size can also function as a shared feature that moderates automatic and self-reported evaluations as well as behavioral intentions. During the acquisition phase a target was presented with two sources – one positive and another negative. When a target was presented in the same size as positive sources it was liked more than a target that was presented in the same size as negative sources. These findings replicate those obtained in Experiments 1 and 3 and demonstrate that different types of shared features lead to the transformation of evaluations and intentions.

**Experiment 5**

In Experiments 1-4, we exclusively focused on how physical features shared by stimuli (e.g., color or size) influence behavioral intentions, automatic and self-reported evaluations. Yet, as we highlighted in the introduction, there are many instances where the features that objects share are conceptual in nature. For instance, minimal group effects can emerge when people are said to share a conceptual relation with one another (e.g., are said to be ‘overestimators’ or ‘underestimators’ based on their prior behavior; e.g., Tajfel et al., 1971). Moral spill-over effects can occur when people are said to share a conceptual relation (e.g., they are family members; Uhlmann et al., 2012). Thus, the shared features principle accommodates feature transformation on the basis of physical and conceptual shared features.

In Experiment 5 we set out to experimentally model conceptual shared feature effects. Specifically, we first trained two conceptual categories that each consisted of two colors (e.g., *Blue-Same-Yellow* and *Green-Same-Purple*) followed bya similar acquisition phase to that used in Experiments 1-3. However, this time, we presented a target object in either blue or green along with a positive and negative source that were presented in either yellow or purple. If a target is presented in blue and a positive source is presented in yellow (along with a negative source in purple) then participants should evaluate that stimulus positively (given that blue and yellow were trained to be conceptually similar to one another in the first phase of the experiment). In contrast, if participants encounter a target in green along with a negative source in purple (and a positive source in yellow) then they should evaluate that target negatively (given that green and purple were trained to be similar to one another during the acquisition phase). Such a finding would further replicate our existing findings and expand the remit of the shared features principle by demonstrating that the shared feature moderating attitude formation can be conceptual rather than purely physical in nature.

**Method**

**Participants and design.** 214 participants (108 females, *Mage =* 30.65*, SD =* 6.08) took part in the study via the Prolific Academic website.

**Procedure**

The study consisted of four phases: color training, acquisition, evaluative measures, and exploratory questions.

**Color training.** Color training consisted of three blocks of 16 training trials followed by one block of 16 test trials. A Matching to Sample (MTS) task was used to establish relations between two sets of colors (e.g., *Yellow-Blue* and *Green-Purple*). On each trial, one color was presented at the top of the screen, and two at the bottom. Participants had to select the color at the bottom that went with the color at the top and were told that corrective feedback provided by the computer would help them do so. When a correct response was emitted then all stimuli were removed from the screen, a feedback message (‘Correct’) presented, followed by a 500ms ITI. If an error was made, stimuli were once again removed, corrective feedback provided (‘Wrong’), an ITI followed by the next trial. Test trials were identical to training trials with the exception that corrective feedback was no longer provided (see Figure 4). Prior research on stimulus equivalence learning shows that such a MTS training procedure results in people responding as if the related stimuli are equivalent (see Hughes & Barnes-Holmes, 2016a).

**Acquisition phase**. Training consisted of three blocks of 16 trials (48 total), with each block containing two types of trials: one type of trial where TO1 was presented in one color (e.g., blue), a positive word was presented in a second color (e.g., yellow), and a negative word was presented in a third color (e.g., purple). In another type of trial TO2 was presented in a fourth color (e.g., green), and the valenced words were presented in the aforementioned colors. Stimulus assignment to the various colors was counterbalanced across participants. All three stimuli were presented against a black background for 5000ms. Thereafter, all stimuli were removed, followed by an inter-trial interval of 750ms, and the next trial (see Figure 5).

**Evaluative measures**. Evaluative measures were similar to Experiments 1-4.

**Exploratory questions**. Participants were asked a similar set of exploratory questions as in Experiments 1-4. We also probed for *color contingency awareness* (i.e., what the relationship was between the various colors), and *TO-SO color contingency awareness* (i.e., if they could recall what color the TOs and SOs were presented in).

**Results**

**Data Preparation**

Fifteen participants failed to provide complete data. A further twenty failed to meet the IAT criteria. This led to a final sample of 179 participants.

**Hypothesis Testing**

**IAT**. IAT scores differed depending on the valence of the SO that shared a color connection with a TO, *t*(168.75) = 3.79, *p* < .001, *d* = 0.57, 95% CI = [0.27, 0.87], BF10 = 109. When TO1 was presented in a color that was equivalent to the color a positive SO was presented in, and TO2 was presented in a color that was equivalent to the color a negative SO was presented in, participants preferred TO1 over TO2 (*M* = 0.14, *SD* = 0.46). When the color contingencies were reversed, participants preferred TO2 over TO1 (*M* = -0.12, *SD* = 0.46).

**Self-reported ratings.** Self-reported scores differed depending on the valence of the SO that shared a color connection with a TO, *t*(169.77) = 7.66, *p* < .001, *d* = 1.15, 95% CI = [0.83, 1.47], BF10 > 106. When TO1 was presented in a color that was equivalent to the color that positive words were presented in, and TO2 was presented in a color that was equivalent to the color that negative words were presented in, participants preferred TO1 over TO2 (*M* = 2.34, *SD* = 4.12). When the color contingencies were reversed, participants preferred TO2 over TO1 (*M* = -2.38, *SD* = 4.09).

**Behavioral intentions**. Participant’s intentions towards TO1 relative to TO2 differed between the two shared features conditions, in a manner that was congruent with prior training. Specifically, the odds that a participant would choose the target object that shared a feature with a positive source object (over the one that shared a feature with a negative source object) were OR = 5.00, 95% CI = [1.91, 13.06], *p* = .001.

**Discussion**

Experiment 5 extends our account further and shows that conceptual shared features give rise to automatic and self-reported evaluations in a similar way to physical shared features. Prior to the acquisition phase, two relations between colors were trained (i.e., *Blue-Similar-Yellow*, and *Green-Similar-Purple*). Thereafter a target object was simultaneously presented with two sources. Critically, the target was presented in either blue (TO1) or green (TO2), whereas positive sources were presented in yellow and negative sources in purple. Self-reported ratings, IAT effects, and behavioral intention measures all indicated that the target presented in blue was preferred relative to the target presented in green, supporting the idea that a shared conceptual feature can led to a transfer of other properties (i.e., valence).

**Experiment 6**

Thus far our findings have been framed as shared feature effects (i.e., as changes in evaluation that occur when stimuli share features with one another). Yet a reviewer suggested an alternative explanation. In Experiments 1-5, a neutral target stimulus either shared a feature with a positive or a negative source stimulus. Rather than the shared feature providing the basis for the change in target stimulus evaluations (e.g., ‘the target is similar to the source in one way [color] and thus is similar in another way [valence]), it may be that an ‘non-shared features’ principle could explain our findings. According to this latter account, stimuli which do not share a feature are evaluated in opposite directions. Thus a neutral target does not acquire its valence from the source it shares a feature with (‘target-*same*-positive source’) but the source that it does not share a feature with (‘target-*opposite*-negative source’).

Experiment 6 sought to replicate and extend our findings while controlling for a ‘non-shared feature’ explanation. In our original acquisition phase three stimuli were always presented: a neutral target along with a positive and a negative source stimulus. We modified this phase so that eight stimuli were now presented: six source stimuli (two positive, two negative, two neutral) along with two target stimuli. During the first half of the trial all stimuli appeared in white. During the second half of the trial one target and one source shared a new color while all other stimuli remained in white. From a non-shared feature perspective, participants should not produce a strong evaluative response in favor of the target stimulus, given that the target does not share a feature with six sources of differing valence. In contrast, the shared features principle would once again predict target evaluations in-line with the valence of a source stimulus that the former shares a feature with.

**Method**

**Participants and design.** 262 participants (119 female, *Mage =* 27.30*, SD =* 7.36) took part in the study via the Prolific Academic website.

**Procedure**

The procedure was similar to Experiment 3 with several exceptions (*see below*).

**Acquisition phase**. Training consisted of three blocks of 16 trials (48 total), with each block containing two types of trials: one type of trial where TO1 and a positive word subsequently shared a color and another where TO2 and a negative word subsequently shared a color. Specifically, each trial contained eight stimuli: two positive sources (either *Love, Happy, Beautiful, Peace, Friendship,* and/or *Success*), two negative sources (e.g., *Agony, Murder, Vomit, Disease, Cancer,* and/or *Torture*), two neutral sources (*Table, Building, Glass, Street, Number,* and/or *Bowl*), as well as two neutral targets (*Morag* and *Struan*). Stimuli were selected from a large valenced word norm study (Moors et al., 2013). All stimuli initially appeared in the same color (white). After 3000ms the color of one target and one source changed (e.g., blue), while the other six stimuli maintained the same color as before (white). Stimuli remained onscreen for another 3000ms before all stimuli are removed, followed by an inter-trial interval of 1000ms, and the next trial. Four stimulus colors were used (lime, fuchsia, yellow, and deepskyblue) and stimulus color was varied across trials so that no color could acquire a specific valence (see Figure 6).

**Evaluative measures**. Evaluative measures were similar to Experiments 1-5.

**Exploratory questions**. Exploratory questions were similar to Experiments 1-5. Note that the phrasing of some of these items were modified so that they made sense in the context of the revised acquisition phase, and for clarity purposes more generally.

**Results**

**Data Preparation**

Twenty two participants failed to provide complete data. A further eight failed to meet the IAT criteria. This led to a final sample of 231 participants.

**Hypothesis Testing**

**IAT**. IAT scores differed depending on the valence of the SO that shared a color with a TO, *t*(227.66) = 7.25, *p* < .001, *d* = 0.96, 95% CI = [0.68, 1.23], BF10 > 106. When TO1 was presented in the same color as positive SOs, and TO2 was presented in the same color as negative SOs, participants preferred TO1 over TO2 (*M* = 0.31, *SD* = 0.51). When the color contingencies were reversed, participants preferred TO2 over TO1 (*M* = -0.18, *SD* = 0.52).

**Self-reported ratings.** Self-reported scores differed depending on the valence of the SO that shared a color with a TO, *t*(227.44) = 12.08, *p* < .001, *d* = 1.58, 95% CI = [1.29, 1.88], BF10 > 106. When TO1 was presented in the same color as positive SOs, and TO2 was presented in the same color as negative SOs, participants preferred TO1 over TO2 (*M* = 3.61, *SD* = 4.72). When the color contingencies were reversed, participants preferred TO2 over TO1 (*M* = -3.40, *SD* = 4.09).

**Behavioral intentions**. Participant’s intentions towards TO1 relative to TO2 differed between the two shared features conditions, in a manner that was congruent with prior training. Specifically, the odds that a participant would choose the target object that shared a feature with a positive source object (over the one that shared a feature with a negative source object) were OR = 14.85, 95% CI = [6.98, 31.63], *p* < .0001.

**Discussion**

Experiment 6 extends our shared feature account still further. It reveals that changes in evaluation occur due to the features that stimuli share with one another rather than the features they do not share. During the acquisition phase participants encountered eight stimuli: two positive sources, two negative sources, two neutral sources, and two neutral targets. During the first half of the trial all stimuli appeared in white. Later on, a target stimulus either shared a new color with a positive or a negative source (while the other stimuli remained in white). According to a non-shared feature account, a neutral target does not acquire its valence from the source it shares a feature with (‘target-same-positive source’) but the source that it does not share a feature with (‘target-opposite-negative source’). Such an account cannot explain the effects reported here given that there were now six stimuli of varying valence that did not share a feature with the target, and this should have led to ambivalent responses towards the target. In contrast, self-reported ratings, IAT effects, and behavioral intention measures all indicated that the target which shared a feature with positive sources was evaluated more positively than the target that shared a feature with negative sources.

**Experiment 7**

Experiments 1-6 demonstrate that when stimuli share features with one another changes in self-reported and automatic evaluations can occur. However, during the review process, a second reviewer asked if such effects are - in part - driven by demand characteristics (i.e., by participants recognizing the contingencies operating within the task and responding, not based on their actual evaluations of the stimuli, but rather on what they believe the researcher wants them to say). When designing the studies we were sensitive to such a possibility and decided to include an indirect procedure (the IAT) which is arguably less susceptible to demand than self-report measures. A third reviewer then asked if IAT effects actually reflect genuine changes in automatic evaluation. Given these respective concerns we decided to once again replicate the shared features effect, but this time using a different indirect procedure which is potentially less sensitive to demand and which is thought to provide a measure of automatic evaluations (i.e., evaluative priming).

In Experiment 7 we decided to replicate the shared feature effect as indexed by self-report, evaluative priming, and behavioral intention measures. This time we focused on size as a shared feature given that we already replicated color-based effects in five of our six studies (and size only once). Replicating our prior findings with an evaluative priming task would argue against a strict demand account, provide further evidence that automatic evaluations emerge, and reinforce our initial claims in the context of size.

**Method**

**Participants and design.** 539 participants (268 female, *Mage =* 28.34*, SD =* 7.47) took part in the study via the Prolific Academic website.[[3]](#footnote-3)

**Stimuli.** The two nonwords MORAG and STRUAN were used as prime stimuli. Targets consisted of ten positive words (e.g., *fantastic, great, nice, good, pleasant, attractive, delight, smile, trust, positive*) and ten negative words (e.g., *terrible, disgusting, nasty, horrible, sick, abuse, failure, grief, negative, pain*).

**Procedure**

The procedure was similar to Experiment 4 with one notable exception: an evaluative priming task was used in the place of an IAT.

**Evaluative priming task**. Automatic evaluations were assessed using an evaluative priming task in which participants are asked to categorize target words as either positive or negative using the E and I keys of a computer keyboard. During all trials, the labels “good” and “bad” appeared on the lower left and right corners of the screen. In line with the procedures of earlier studies (e.g., Van Dessel, Gawronski, Smith, & De Houwer, 2017), a single trial consisted of a fixation cross presented for 500 ms, a blank screen for 500 ms, a prime for 200 ms, a blank screen for 50 ms, and the presentation of a target word. The inter-trial interval was set to vary randomly between 500 ms and 1500 ms. Whenever an incorrect response was made or participants did not respond prior to the response deadline of 1500 ms, ‘Wrong’ was displayed in the center of the screen for 250 ms before the next trial. Participants were asked to respond as quickly as possible without making too many errors. With the two types of primes and two types of targets, there were four prime-target combinations. Participants first completed eight practice trials, which were then followed by eighty critical test trials. The test trials were presented in a single block, with each of the four types of prime-target combinations presented twenty times in random order.

**Results**

**Data Preparation**

Forty six participants failed to provide complete data. One additional participant was excluded due to an error with the evaluative priming task. This led to a final sample of 487.

**Evaluative priming**. Latencies from incorrect responses in the evaluative priming task (4.26%) were eliminated and outlier latencies longer than 1000 ms and shorter than 300 ms (9.69% of the correct responses) were removed. From the remaining trials we calculated two evaluative priming scores – one for MORAG and another for STRUAN. In each case the score was computed by subtracting reaction times on trials where a prime was followed by a negative target from trials where a prime was followed by a positive target. We then created an overall priming score by subtracting the prime score for STRUAN from that for MORAG.

**Hypothesis Testing**

**Evaluative priming**. EP scores differed depending on the valence of the SO that shared a size with a TO, *t*(484.67) = -2.71, *p* = .007, *d* = -0.25, 95% CI = [-0.42, -0.07], BF10 = 3.49. When TO1 was presented in the same size as positive SOs, and TO2 was presented in the same size as negative SOs, participants preferred TO1 over TO2 (*M* = -7.56, *SD* = 57.83). When the size contingencies were reversed, participants preferred TO2 over TO1 (*M* = 7.06, *SD* = 61.09).

**Self-reported ratings.** Self-reported scores differed depending on the valence of the SO that shared a size with a TO, *t*(478.23) = 12.88, *p* < .001, *d* = 1.17, 95% CI = [0.98, 1.36],BF10 > 106. When TO1 was presented in the same size as positive SOs, and TO2 was presented in the same size as negative SOs, participants preferred TO1 over TO2 (*M* = 2.17, *SD* = 4.35). When the color contingencies were reversed, participants preferred TO2 over TO1 (*M* = -2.70, *SD* = 3.98).

**Behavioral intentions**. Participant’s intentions towards TO1 relative to TO2 differed between the two shared features conditions, in a manner that was congruent with prior training. Specifically, the odds that a participant would choose the target object that shared a feature with a positive source object (over the one that shared a feature with a negative source object) were OR = 4.43, 95% CI = [2.82, 6.95], *p* < .0001.

**Discussion**

Once again self-reported and automatic evaluations as well as behavioral intentions emerged when stimuli shared a feature with one another. We not only replicated our finding that size can function as a shared feature but also generalized them from one indirect procedure (IAT) to another (evaluative priming).

**Experiment 8**

In the introduction we argued that many phenomena in psychological science may represent instances of the shared features principle. Yet so far we have almost exclusively relied on artificial stimuli (nonsense words) to demonstrate the principle itself. Although these stimuli bear similarity to certain real-world items (e.g., the names of novel brands or social groups) a more socially relevant demonstration seems warranted in order to support the larger claim being made here. With this in mind we created an entirely new task that employed a more socially relevant set of stimuli (male faces) that shared a novel feature (common location). This task was designed to function as an experimental analogue of a classic social psychological manipulation: the minimal groups paradigm, a task frequently used to study intergroup processes and which set the stage for two highly influential theories: Social Identity Theory (Tajfel, Turner, Austin, & Worchel, 1979) and Self Categorization Theory (Turner, Hogg, Oakes, Reicher, & Wetherell, 1987).

The minimal groups paradigm involves a situation where participants are assigned to different groups. This assignment is typically arbitrary (i.e., based on some trivial criteria such as a coin toss or a shared preference for certain paintings), novel (not based on any pre-existing criteria), anonymous (participants lack awareness of who is assigned to their group and never interact with them), and as such, intergroup evaluations or resource allocation serves no direct utilitarian self-interest. Despite this participants still demonstrate a relative preference for the group to which they have been assigned: they often allocate resources in ways that favor their own group, view other group members favorably, and as being more similar to them than outgroup members (for a recent review see Otten, 2016).

From a shared features perspective, the minimal groups paradigm represents a situation where individuals are arbitrarily assigned to the same group based on some shared feature (e.g., similar clothing item or preference for certain paintings), and as a result, people then assume that those same individuals share other features as well (e.g., valence or personality traits). Drawing on this idea we created a task where individuals did not share a feature with other individuals but rather with valenced events. Specifically, prior to the acquisition phase, participants were informed that the computer would pull images and words from two bags. Participants then saw a single stimulus onscreen (either an unknown male face or a positive or negatively valenced word) along with information highlighting from which bag that stimulus was pulled (e.g., “pulled from Bag 1”). Across trials they could learn that one neutral face (Target 1) was pulled from the same bag as positive words whereas a second face (Target 2) was pulled from the same bag as negative words. If the shared features principle is correct, then the fact that a target (neutral face) and source (valenced image) share one feature (common bag location) may lead participants to infer that they share other features (valence).

It is worth noting that the acquisition phase was constructed so that stimuli appeared one at a time in random order. As such there was no contingency between the valenced sources and neutral targets. Moreover, the task ensured that any contiguity between stimuli favored a neutral target being related to positive and negative stimuli in equal measure. Thus it is unlikely that our effect were driven by mere contiguity (i.e., they do not represent instances of EC). Nevertheless, we decided to add a second condition in order to demonstrate that it was the shared feature and not mere pairing of stimuli that moderated evaluations. Participants in this condition encountered a similar acquisition phase as outlined above but with one notable exception: information about which stimulus was pulled from which bag was never presented. An absence of evaluative responding in this condition would suggest that evaluations are dependent on shared features.

Finally, during the review process, a reviewer argued that would be an even stronger demonstration if people were to still demonstrate evaluations even when they were told that the words and images were being pulled from the two bags at random. In other words that there was no connection between target and sources and that there is no such thing as a good or bad bag. We therefore included a third condition which was similar to the first condition with one exception: prior to and during the acquisition phase participants were informed that bag assignment was random and that neither bag was privileged with a particular valence. If effects were to emerge here then it would suggest that shared features can guide evaluations even when people are told that those features are irrelevant and should be disregard.

**Method**

**Participants and design.** 245 participants (140 female, *Mage =* 29.17*, SD =* 7.48) took part in the study via the Prolific Academic website. A single factor between-participants design with three levels (*Minimal Groups*: Related vs. Unrelated vs. Random) was used and the same method factors manipulated as in Experiments 1-7. Data-collection was terminated when 240 participants completed the experiment. Recruiting 204 participants provided sufficient power (> 0.90) to observe a medium effect (*f* = 0.25) at alpha = 0.05. We decided to collect additional participants in order ensure that the necessary sample size was still obtained following exclusions.

**Stimuli**. Two unknown male images (labelled Chris and James) served as target stimuli while ten positive (*fantastic, wonderful, honest, kind, brave, amazing, nice, pleasant, selfless, great*), ten negative adjectives (*horrible, nasty, violent, terrible, hated, disgusting, mean, unpleasant, stupid, bully*) served as source stimuli.

**Procedure**

The procedure was similar to Experiment 3 with several exceptions (*see below*).

**Acquisition phase**. In all three conditions training consisted of three blocks of 12 trials (36 total) consisting of four different randomly presented trial-types: those that displayed either Target 1, Target 2, a positive word, or a negative word by itself in the middle of the screen for 4000ms. The stimulus was then removed and a 2000ms ITI onset. Each condition then varied in several additional ways.

*Shared feature (location) condition*. Prior to the acquisition phase participants were told that the computer would pull a word or image from two bags (e.g., Bag 1 and Bag 2) and then display that word or image onscreen. During each trial a label was presented above the stimulus indicating from which bag it was pulled (i.e., “Pulled from Bag 1”, “Pulled from Bag 2”, “Pulled from Bag 3”, “Pulled from Bag 4”, “Pulled from Bag 5”, “Pulled from Bag 6”). The label assignments were varied as a function of block number and stimulus identity, such that Target 1 and positive words were assigned to Bag 1 in block 1, Bag 3, in block 2, and Bag 5 in block 3 whereas Target 2 and negative words were assigned to Bag 2 in block 1, Bag 4, in block 2, and Bag 6 in block 3 (see Figure X).

*Random condition*. Prior to training participants were told that the computer would pull a word or image from two bags, display that word or image onscreen, along with information about the bag it was selected from. They were also told that the contents of each bag was randomly created. Therefore there was such thing as a ‘good’ or ‘bad’ bag nor was there a connection between the words or images pulled from each bag. Participants were required to complete a manipulation check to ensure that they fully understood and processed these instructions before proceeding to a similar acquisition phase as in the shared features condition.

*No contiguity condition*. Prior to training participants were informed that the computer would display a word or image and that they should pay attention to these items. During the acquisition phase itself, no information about bag assignment was provided. Instead each stimulus was randomly presented by itself in a non-contingent manner.

**Evaluative measures**. Evaluative measures were similar to Experiments 1-6.

**Exploratory questions**. Exploratory questions were similar to Experiments 1-6. Note that the phrasing of some of these items were modified so that they made sense in the context of the revised acquisition phase, and for clarity purposes more generally (see Supplementary Materials).

**Results**

**Data Preparation**

Seventeen participants failed to provide complete data. A further three failed to meet the IAT criteria. This led to a final sample of 222 participants.

**Hypothesis Testing**

**IAT**. IAT scores differed as a function of Minimal Group condition, *F*(2, 219) = 28.26, *p* < .0001, *ηp2* = .21, 95% CI = [0.12; 0.29], BF10 > 104. Planned pairwise comparisons with Bonferroni-Holm corrections for multiple testing indicated no evidence that IAT scores were different between the shared features condition (*M* = 0.28, 95% CI [0.18, 0.38]) and random conditions (*M* = 0.16, 95% CI [0.06, 0.26], pairwise *p* = .10), but provided evidence that both the shared features and random conditions differed from the no-contiguity condition (*M* = -0.20, 95% CI [-0.29, -0.12]; both pairwise *ps* < .0001).

**Self-reported ratings.** Ratings differed as a function of Minimal Group condition, *F*(2, 219) = 26.70, *p* < .0001, *ηp2* = .20, 95% CI = [0.10; 0.27], BF10 > 104. Planned pairwise comparisons with Bonferroni-Holm corrections for multiple testing indicated no evidence that IAT scores were different between the shared features condition (*M* = 2.61, 95% CI [1.72, 3.49]) and random condition (*M* = 2.10, 95% CI [1.21, 3.00], pairwise *p* = .39)[[4]](#footnote-4), but provided evidence that both the shared features and random conditions differed from the no-contiguity condition (*M* = -1.14, 95% CI [-1.78, -0.50]; both pairwise *ps* < .0001).

**Discussion**

We once again obtained shared feature effects when a new feature (common location), set of socially relevant stimuli (faces), and procedure were employed. Not only did shared features guide intentions, self-reported and automatic evaluations, but seemed to do so even when people were told that they were irrelevant and should be disregard.

**Meta Analysis**

In order to a) better estimate the evidence for an magnitude of learning via shared features and b) determine the likelihood of observing shared features effects under other experimental conditions (i.e., to provide information about the *generality* of the effect itself), we carried out meta-analyses of Experiments 1-8. In the case of Experiment 8, we included both conditions that involved a shared feature that could be learned from (i.e., the standard condition and the instructed randomness condition). Total sample size drawn from for the meta analyses was therefore *N* = 1525. Random effects meta analysis models were fitted using the metafor R package (Viechtbauer, 2010) and the maximum likelihood estimator function. A separate was fitted for each outcome variable (IAT, self-report ratings, and behavioral intentions; note that not every experiment contained every measure). Our general strategy was to first fit a meta-analytic model and assess for heterogeneity. If heterogeneity was undesirably large then we tested for the presence of outlier experiments using metrics of both excessive influence on the meta analyzed effect size (ΔSDeffect size) and excessive influence on heterogeneity (Δτ2) via leave-one-out analyses. Studies were only labeled as outliers if results from these tests were consistent across all three outcome variables (i.e., IAT, self-reports, & behavioral intentions). Analyses indicated that Experiment 2 was an outlier on the basis of undue influence on both the meta-analyzed effect size and heterogeneity and across all three outcome variables (full results from each metric available at [osf.io/vbk54](https://www.osf.io/vbk54/)). This was also congruent with our previous observation that the different instructions employed in Experiment 2 may have undermined the effect. As such, it was excluded and a second meta-analytic model was refit in each case. The results of both models are reported below.

**IAT**

Fitting a meta-analytic model to the IAT revealed a significant effect of medium size (Cohen, 1988): *k* = 8, *d* = 0.75, 95% CI = [0.42, 1.07], 95% CR = [-0.14, 1.63], *p* < .0001. However, results were found to contain a high degree of heterogeneity, *Q* (*df* = 7) = 36.81, *p* < .001, τ2 = 0.18, *I*2 = 83.28%, *H*2 = 5.98. Following the exclusion of Experiment 2 as an outlier, the meta-analyzed effect size was still found to be significant and had moved from medium to large effect size, *k* = 7, *d* = 0.86, 95% CI = [0.67, 1.06], 95% CR = [0.47, 1.26], *p* < .0001, and heterogeneity was found to lower, *Q*(*df* = 6) = 11.24, *p* < .001, τ2 = 0.03, *I*2 = 47.02%, *H*2 = 1.89.

**Self-Report Ratings**

Fitting a meta-analytic model to the self-report ratings revealed a significant effect of large size, *k* = 9, *d* = 1.00, 95% CI = [0.62, 1.37], 95% CR = [-0.14, 2.13], *p* < .0001, but with a high degree of heterogeneity: *Q*(*df* = 8) = 68.6, *p* < .001, τ2 = 0.3, *I*2 = 90.66%, *H*2 = 10.71. After excluding Experiment 2, the meta-analyzed effect size was still significant and now of very large size (Sawilowsky, 2009), *k* = 8, *d* = 1.16, 95% CI = [0.92, 1.41], 95% CR = [0.53, 1.8], *p* < .0001, and heterogeneity was found to be reduced, *Q*(*df* = 7) = 22.59, *p* < .001, τ2 = 0.09, *I*2 = 75.02%, *H*2 = 4.

**Behavioral Intentions**

Fitting a meta-analytic model to behavioral intentions revealed a non-significant meta-analytic effect of medium size (Chen, Cohen, & Chen, 2010): *k* = 7, Odds Ratio = 4.76, 95% CI = [1.7, 13.33], 95% CR = [0.31, 72.97], *p* = .003, and with a high degree of heterogeneity: *Q*(*df* = 6) = 42.14, *p* = 0.003, τ2 = 1.67, *I*2 = 89.76%, *H*2 = 9.76. After excluding Experiment 2, the meta-analyzed effect size was significant and now of large size, k = 6, Odds Ratio = 7.32, 95% CI = [4.53, 11.7], 95% CR = [3, 17.81], *p* < .0001, with negligible heterogeneity, *Q*(*df* = 5) = 8.97, *p* < .001, τ2 = 0.15, *I*2 = 45.08%, *H*2 = 1.82.



*Figure 1*. Forest plots for IAT (top), self-report (middle), and behavioral intentions (bottom). Note: Experiment 2 was excluded as an outlier following tests for excessive heterogeneity.

**Robustness Tests**

In our preregistered analytic plan we stated we would examine the robustness of the shared feature effect when only considering participants who were (a) contingency aware (including both US contingency aware and color-valence contingency aware), (b) not demand compliant, (c) not influence aware, or (d) not hypothesis aware. These exclusions are common in the EC literature: contingency awareness is often a necessary condition to observe evaluative effects (thus it was required; Hofmann et al., 2010), whereas the other three factors ensure that our effects were not contaminated by undesirable sources (thus they were excluded). Given that each individual study lacked the power to address this question we opted for a meta-analytic approach instead. Each respective subset of participants was excluded and separate meta-analytic models were refit. As in the previous meta analyses, robustness tests excluded Experiment 2 as an outlier. Robustness of conclusions was defined as congruence in the acceptance/rejection of the null hypothesis between results obtained from the full sample and those obtained in a given subset.

Results were found to be robust to including only participants who (a) were contingency aware (i.e., US contingency aware [77.5% of participants] and color-valence contingency aware [59.5%]), (b) were not demand compliant (80.9%), and (c) were not influence aware (47.4%). This was found across all three outcome measures (IAT, self-reported evaluations, and behavioral intentions; all sensitivity analysis effect size *p*s < .0001) with one exception: results on the behavioural intentions were not robust to including only participants who were not influence aware (full sample *p* < .0001, sensitivity analysis *p* = .083). However, results were not robust to (d) including only participants who were not hypothesis aware (26.7% of participants) on any of the three outcome variables (all *p*s >.13). In short, the general trend of evidence suggested that learning via shared features is robust to three common exclusions employed in the literature: requiring participants to be contingency aware, not demand compliant, and not hypothesis aware. It was not found to be robust to requiring participants to not be influence aware. Although, we noted that this exclusion removed a particularly large proportion of participants. As such, it is possible that lack of robustness here may have been driven by the tests relatively lower statistical power.

**General Discussion**

In this paper we introduced the shared features principle which postulates that when two stimuli share one feature people assume that they also share other features as well. Although this principle may underpin many different phenomena in psychological science we sought to illustrate its predictive value in the domain of attitudes, test its potential boundary conditions, and demonstrate that it holds across different physical and conceptual features, outcome measures, and training procedures. Across eight studies we exposed participants to an acquisition phase that typically contained three stimuli: a neutral target, a positive source, and a negative source. We then manipulated each trial so that a target would either share a common color (Experiments 1, 2, 3, 6), size (Experiments 4 and 7) or location (Experiment 8) with one of the source objects. To demonstrate that our account speaks to both physical and conceptual features, Experiment 5 created two conceptual color categories (*Blue-Similar-Yellow*, and *Green-Similar-Purple*) and then, during the acquisition phase, presented a target in either blue or yellow and the sources in green or purple. In all experiments except Experiment 2, we observed that liking of the target object changed in the direction of the valence of the source object with which the target object shared a feature. The unexpected results of Experiment 2 were likely a consequence of instructions that directed attention away from shared features and towards changes in stimulus features (for more *see below*).

Taken together, our results provide strong and repeated support for the shared features principle. Changes in liking were not driven by mere contiguity but instead by the features targets and sources shared with one another. These shared feature effects were evident from self-reported ratings, behavioral intentions, evaluative priming and IAT effects which consistently favored one target over the other. They also emerged regardless of the type (color, size, location) and nature (physical or conceptual) of feature manipulated and acquisition procedure used. These conclusions were further reinforced by our meta analysis, where shared features were shown to produce large effect sizes across measures of automatic evaluation, and self-reported evaluation, and behavioural intentions. The relatively large degree of heterogeneity in the effect sizes between studies reflects the differing instances and implementations of shared features that were implemented between studies. Encouragingly, the credibility intervals (i.e., 95% CR, which reflect the likely range of effect sizes to be observed given both the estimated true effect size and the observed heterogeneity between studies) excluded zero by a large margin for all outcome variables (IAT, self-reports, and behavioral intentions), suggesting that learning via shared features is also highly likely to be observed in future studies under other as-yet unobserved implementations of the concept. We can therefore say that the shared features effect appears to be replicable, robust across a range of outcome measures and common exclusion criteria, and general across multiple instances and implementations.

**Theoretical Implications**

Until now we focused on the shared features principle itself and said little about why it actually emerges. There are two different levels at which to explain shared features effects (De Houwer, 2011; Hughes, De Houwer, & Perugini, 2016): (1) a mental level that aims to uncover the mental mechanisms that *mediate* the impact of the environment on behavior and (2) a functional level that aims to describe those elements of the environment that *moderate* behavior. We consider both in turn.

**The functional level of explanation: The sharing of features as a contextual relational cue.** Without going into too much detail, functional explanations are not concerned with identifying mental representations and processes. Instead they seek to relate specific effects to more general behavioral principles using terms that refer to the function of events (for a detailed treatment see Hughes & Barnes-Holmes, 2016a; De Houwer & Hughes, 2019). At this level shared features effects could be conceptualized as an instance of relational responding (i.e., a type of behavior that involves ‘responding to the relationship between stimuli’). Relational responses are typically emitted in the presence of a stimulus called a *relational contextual cue*. This stimulus is a *contextual cue* in the sense that it signals (cues) how one should respond, and it is *relational* because it signals that a relational response should be emitted in that context. Take, for instance, a non-relational contextual cue such as a red traffic light at a busy intersection. This light signals how one should respond in that context (i.e., that walking across the street when the light is red will be dangerous for that person). Relational contextual cues require us to take this idea one step further. They also signal how one should respond. But instead of responding to just one stimulus they indicate that we should respond based to how stimuli are *related* to one another in that context.

To illustrate, imagine that you are presented with a positive word along with an unknown word. If this pair of stimuli is accompanied by the word ‘SAME’ this may signal to you that the unknown word has the same (evaluative) meaning as the positive word. As a result you will subsequently like the unknown word more than before. In this example the word SAME functions as a relational contextual cue: it signals that a relation of similarity exists between the unknown and positive word. One could conceptualize shared physical features such as color (Experiments 1,2,3,6), size (Experiments 4, 7) and location (Experiment 8) in much the same way: as a relational contextual cue which signaled a relation of similarity between two of the three stimuli presented in an acquisition trial (a neutral target and either a positive or negative source). Once such a relationship was formed other source features were transferred to the target (valence), thus leading to a change in evaluative responding. The fact that conceptual features also moderated evaluations and intentions (Experiment 5) is consistent with past work on the effects of relational contextual cues (Hughes & Barnes-Holmes, 2016a). Thus, our shared feature effects are in line with modern (functional) conceptualizations of learning and behavior (e.g., Hayes, Barnes-Holmes, & Roche, 2001), and particularly with the idea of relational contextual cues.

**The mental level of explanation: Inferential reasoning.** At themental level the goal is to identify the mental representations and processes that mediate between environment and behavior. We believe that shared feature effects fit well with an inferential perspective on human learning and attitudes (e.g., De Houwer, 2018; Van Dessel, Hughes, & De Houwer, 2018). The core conceptual unit of this perspective is a proposition, that is, an informational unit “that contains information about the nature of the relation between stimuli (e.g., A predicts B, A causes B, A co-occurs with B, …)” (De Houwer, 2018, p.3). *Inferences* represent a sub-type of such propositions – namely – those generated from other momentarily available propositions. “The construction process that leads to the inference can be seen as an information generation procedure that involves the application of information generation (i.e., inference) rules to information that is currently entertained” (Van Dessel et al., 2018, p.4). [[5]](#footnote-7)

In our studies the fact that the source and target object shared a feature may have caused participants to form a series of inferences about (a) how those stimuli were related and (b) the properties of the target object. It might have been these inferences which mediated subsequent evaluations and intentions. For instance, during the acquisition phase in Experiments 1-5, participants may have formed a number of simple propositions concerning the source and target objects (e.g., ‘the target is presented in green’, ‘the positive source is presented green’, and ‘the negative source is presented in purple’). They may have also generated a number of propositions about the source and target object features (e.g., ‘this word [target] is neutral’, ‘that word [source] is positive’ and ‘that word [source] is negative’). These basic propositions may have served as the ‘raw ingredients’ for a relational inference (‘the target and source are similar in that they are both green’), and thus an inference about the target objects features (‘the source is good therefore the target is also good’). Note that these inferences were generated on the basis of both physical and conceptual features that objects shared. Thus, from an inferential perspective, the ‘assumptions’ at the core of shared feature effects are actually inferences that are constructed on the basis of past and present propositions about the source and target objects, their features, and how they are related.

**Open Questions, Broader Implications, and Future Directions**

It is important to realize that our account is not limited to attitudes but speaks to human behavior more generally. The shared features principle may also lead to a change in non-evaluative stimulus properties in ways that are relevant to clinical (e.g., fear, anxiety, disgust), social (accessibility), consumer (brand quality, identification), health (avoidance, escape), and cognitive psychology (attention). Indeed, we found in Experiment 8 that shared features could be used to establish implicit and explicit first impressions of an unknown person (i.e., for person perception). Future work could push this idea even further using the procedures outlined here. If we are correct then the shared features principle may underpin many known and to-be-discovered phenomena throughout psychological science.

We also limited our initial efforts to the formation of attitudes. Future work could investigate whether shared features can also be used to strengthen or revise existing evaluations as well. For instance, researchers could establish a novel evaluation towards an unknown object, or take a pre-existing evaluations towards a known object (e.g., towards a celebrity, brand product, phobic, or clinically relevant stimulus such as spiders or alcohol). Those evaluations could then be modified using a similar task as used in Experiments 1-5. For instance, imagine that participants first complete the same acquisition phase as we used here to generate an evaluation and were then exposed to similar phase designed to reverse those initial evaluations. Researchers could vary this second task so that the target no longer shares a color with either type of source (similar to extinction in EC research; e.g., Gawronski, Gast, & De Houwer, 2015), swap the shared feature contingencies so that the target now shares a feature with the opposite source used in the first phase (similar to counter conditioning in EC research; Kerkhof, Vansteenwegen, Baeyens, & Hermans, 2011) or is exposed to the exact same contingencies as before, but between the formation and change phases, the source the target share a feature with is subjected to a US-revaluation procedure. In each case, they could examine if evaluations of the target change as a result of such manipulations.

When carrying out this work, researchers should also investigate the factors that moderate shared feature effects. Such work could examine if the type and nature of the shared features, or the properties of the source and target objects, or the types of features being transformed from one object to another matters across different domains. How shared features are established and changed may also matter: it may be easier to form and modify these effects via experience relative to observation or instruction. Our work identified one such boundary condition: attention. In Experiments 2-3 directing attention towards the shared feature led to automatic and self-reported evaluations whereas directing attention away from that feature eliminated or even reversed the effect. One possibility is that people treat shared features as a cue that is ‘diagnostic’ for how they should respond to the target object (i.e., how they should evaluate the target). It may be that the impact of shared features on behavior is moderated by other cues in the environment which signal to what extent the shared feature is diagnostic or not when making a judgement. This is worthy of further study. There may be still other conditions necessary for these effects to emerge and change that should also be examined. The current studies utilized two types of procedure to document these effects and readers should be careful not to conflate the former with the latter. Many other procedures could be devised to study this class of effects.

We previously argued that shared features could be conceptualized as relational contextual cues. If so, then it should be possible to change the relational meaning of the fact that objects share features, and thus the assumptions people make about target object features on the basis of those shared features. Although a shared feature will typically signal that the source and target objects are similar to one another (and thus give rise to *feature transfer*) there is no reason why a shared feature cannot instead signal that the source and target are related in other ways (and thus give rise to *feature transformation*). For instance, it may be that the feature shared by a source and target object signals that those objects are opposite, hierarchical, different, or related in any number of other ways. This also seems like a promising research direction for future research.

Another interesting possibility is that opposite features may influence behavior as well. In a recent set of studies De Houwer and Hussey (2019) exposed participants to a simple learning task where participants had to assign valenced words to the left-side of the screen and unknown nonsense words to the right-side of the screen. Following training the nonsense words acquired an opposite valence to the valence items themselves. In this case, a source (valenced) and target (nonsense word) object did not share a feature with one another but possessed an opposite feature (i.e., one was linked to a left response and the other to a right response). The fact that they possessed opposite features (i.e., that they were assigned to opposite responses) may have led people to make certain assumptions about the target object based on the source object features (i.e., that the nonsense words had an opposite valence to the source). If so then there may be an ‘opposite features effect’ waiting to be systematically explored.

Finally, our findings lead to new perspectives on learning in general. In this area researchers have long made a distinction between acquisition (the emergence of a novel response in the presence of a stimulus) and generalization (the transfer of response-eliciting properties from one stimulus to another). In evaluative conditioning, for instance, researchers initially utilize an acquisition phase with stimulus pairings to generate an evaluative response to a conditioned stimulus, and then use a generalization phase to test if this evaluative response transfers from one conditioned stimulus to another (e.g., Till & Priluck, 2000). Yet our work suggests that the spatio-temporal pairing of stimuli might just be one way to induce a shared feature that provides the basis for feature transformation. We also argue that the shared features principle is itself rooted in the phenomenon of generalization. If we combine these two ideas we arrive at an interesting new possibility: acquisition and generalization may be more similar to one another than previously thought. For instance, in evaluative conditioning, EC effects can be conceived of as a transfer of evaluative properties based on the fact that stimuli share some *other* property with one another (common location in space and time). Evaluative generalization effects can also be conceived of as a transfer of evaluative properties based on the fact that stimuli share some *other* property with one another (common physical or conceptual property). In other words, acquisition and generalization can both be seen as feature transformation effects that occur when objects share features. When viewed in this way we see that acquisition research has often tended to focus on one shared feature (spatio-temporal properties) whereas generalization research has focused on others (perceptual or conceptual features). Yet from a shared features principle perspective, acquisition and generalization may both be instances of feature transformation.

**Conclusion**

In this paper we introduce the shared features principle and provide an initial test of its heuristic and predictive value. We found that when a valenced source and neutral target object shared one feature with one another (color or size), this was enough to influence assumptions about other features of the target (valence). This was true for both automatic and self-reported evaluations and when the type and nature of the shared feature was varied. Across experiments and in meta analyses, the principle was found to produce effects that were replicable, robust, and general. Although this paper focused on just one domain (attitudes) our conceptual account applies to many more, and offers a unified way to describe and analyze shared feature effects throughout psychological science. In all likelihood, there are many other domains and phenomena that could be conceptualized as instances of shared feature effects than covered here. We hope that our account will stimulate a new wave of research on this topic and contribute to a broader and deeper understanding of the way in which people arrive at assumptions about the features of objects in their environment.

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1. We distinguish target and source feature from target and source objects because the target and source features can either be part of the same object or they can be part of different objects (for a more detailed treatment see De Houwer et al., 2019). In the case of shared features effects the source and target objects are typically different. [↑](#footnote-ref-1)
2. Note that this requirement excludes feature transformation effects that are due to related features. For instance, in endowment effects (Kahneman, Knetsch, & Thaler, 1990) and mere ownership effects (Beggan, 1992), people ascribe more value to things that they own. In this case feature transformation does take place (e.g., people assume that the object is higher in value or status because it is related to the self). However, this change in assumptions about the object is not due to the fact that the person and object share a feature. In fact, the person-object relation implies that the person and object have different features (i.e., the person is the owner whereas the object is owned). Although such related features (i.e., features that are different aspects of a single relation) could also underlie feature transformation, we differentiate related features from shared features as functional cause of feature transformation. One reason for this is that it is unclear how related features influence similarity whereas there are good arguments for assuming that shared features increase similarity (Tversky, 1977). As such, unlike feature transformation because of shared features, feature transformation because of related features might not be grounded in generalization. [↑](#footnote-ref-2)
3. Given the unreliable nature of the evaluative priming effect, large sample sizes typically required to find EP effects, and our uncertainty about the size of the EP effect we might obtain, we opted to use a Sequential Bayes Factor (SBF) design with a maximal N (e.g., Schönbrodt, & Wagenmakers, 2018). Specifically, we use a threshold of > 3 or < 0.16, a minimum of 300 participants, an addition of 100 participants for each test, and a maximum of 500 participants (which was the maximum number our resources allowed). [↑](#footnote-ref-3)
4. We were somewhat surprised to find an evaluative effect favoring one of the male images over the other in the no-contiguity condition given that neither image was presented in contiguity with valenced images nor was there a contingency between those various items. We therefore performed a replication of this one condition with a different randomization method to examine if comparable evaluations once again emerged. Analyses revealed an evaluative effect on the IAT, *t*(88) = -3.90, *p* = .0002, *d* = -0.41, and self-reported ratings, *t*(88) = -5.71, *p* < .0001, *d* = -0.61 favoring the same male image over the other. Thus it seems the effect in the no-contiguity condition was likely driven by a relative preference for one stimulus over another that is not a function of stimulus contiguity or contingency (i.e., this effect is not an instance of EC; for more details see [osf.io/vbk54](https://osf.io/vbk54/)). [↑](#footnote-ref-4)
5. In this way the term ‘inference’ describes the outcome of the computation process rather than the computation process itself. The computational process of inferential reasoning can occur on the basis of many different inference rules (e.g., rules that encode general statements about the world [if-then rules] or rules based on mere similarity [analogical mapping rules]; for more see Van Dessel et al., 2018). [↑](#footnote-ref-7)