Conceptual associations guide social inference

by

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DEDICATION

For Nicole.

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ABSTRACT

In order to efficiently navigate our social world, humans sort one another along dimensions and categories intended to reflect the structure of human behavior. Popular models of social perception generally theorize a relatively fixed detection process to identify functionally and adaptively significant social attributes (e.g., warmth, competence, anger, race). However, recent research suggests considerable malleability in social perception, which is not adequately accounted for by current models. Here I argue that a number of social perception phenomena may be parsimoniously explained not by a set of fixed detectors but by a domain-general account of spreading activation between social concepts through an associative network. Specifically, I propose that, similar to other forms of non-social inference, perceivers form a knowledge structure of what social concepts exist in the world (e.g., frequent speakers are 'extroverted') and how those concepts associate with one another (e.g., 'extroverted' people are often 'kind' and 'male'), and they then use this structure to make inferences (e.g., 'this kind male is likely extroverted'). Although quite simple, this perspective provides rich predictions that may describe many facets of the social perception process, such as how perceptions vary in their initial formation from cues, automaticity and temporal dynamics, variance within and between perceivers and contexts, and dimensional and categorical structure. This perspective also helps integrate theory of social perception, bridging both perceptual classes (e.g., traits, social categories, and emotion) and their contexts (e.g., face impressions, person knowledge, and group stereotyping).

To provide an initial test of this perspective, I examine how social perceptions (e.g., warmth, extroversion) correlate with one another along the lines of their conceptual

associations (e.g., 'are warm people likely to be extroverted?'). In Chapter 1, we demonstrate that face-based trait impressions color one another in to the extent they are conceptually associated. Faces perceived to possess one personality trait (e.g., trustworthiness) elicited additional trait impressions (e.g., creativity) to the extent perceivers conceptually associated the traits (e.g. 'trustworthy people are often creative'). Chapter 2 extends the findings of Chapter 1 across contexts of social cognition, where the same conceptual structuring of trait impressions emerged across the domains of face impressions, familiar person knowledge, and group stereotype content. Lastly, in Chapter 3, I apply this perspective to the domains of emotion recognition and social categorization. Survey, mouse-tracking, and neuroimaging analyses showed categories apparent in a face (e.g., 'male') facilitated or impaired perceptions and neural representations of other categories (e.g., 'black') to be in accordance with their conceptual associations. Together, these findings provide evidence for a domain-general account of social perception, which assumes only basic semantic-processing principles, accounts for a number of social perception phenomena, and generates several new theoretical predictions. Overall, this research demonstrates that the perceptions and dimensions which emerge in social perception are bound to perceivers' conceptual representations of the social world.

INTRODUCTION

People develop rich concepts of one another with remarkable ease. Across complex and broad social contexts, we seamlessly infer others' mental states, personality traits, and category memberships (Asch, 1946; Brewer, 1988; Fiske & Neuberg, 1990; Gopnik & Wellman, 1994). To navigate an exceedingly large and complex social world, we must efficiently make these inferences, which streamline our momentary interactions to large-scale societal decisions. The functional importance of social perception inspired prominent theories that are largely bottom-up in nature, where perceivers track a relatively fixed set of others' social attributes that hold adaptive significance. For example, important theories describe fundamental perceptual categories and dimensions of emotion (the 6 basic emotions; Ekman, 1993), social categories (the big 3: race, gender, and age; Macrae & Bodenhausen, 2000), and personality traits (the big 2: competence and warmth; Fiske, Cuddy, & Glick, 2007). These dimensions emerge across perceptual contexts, from face perception to group stereotypes. However, recent research has unveiled a more malleable social perception, where these dimensions may shift substantially (Freeman & Ambady, 2011a; Gendron, Roberson, van der Vyver, & Barrett, 2014; Hehman, Sutherland, Flake, & Slepian, 2017). Here I provide evidence that a broad set of instances of social perception may be parsimoniously explained by a domain-general cognitive account, where social inferences and the structure underlying them emerge from the spreading activation of social concepts in an associative network.

A malleable social perception

Perceivers may easily infer almost anything about others. For instance, even when presented merely with a face, we leave with a sense of a target's emotional state, trustworthiness,

creativity, gender, race, and even perhaps a hunch towards the target's political affiliation,

religion, mental health, occupation, or relationship preferences (Freeman & Ambady, 2011a;

Oosterhof & Todorov, 2008; Rule, Garrett, & Ambady, 2010; Rule & Sutherland, 2017).

Research has extensively documented cues that reliably relate to such inferences. For instance,

cues such as pigment pertaining to race exemplars underlie race categorization (Locke, Macrae,

& Eaton, 2005) and facial maturity and strength cues lead to inferences of competence

(Oosterhof & Todorov, 2008; Zebrowitz & Montepare, 2008).

Increasingly, however, social perception has been shown to be a highly context-

dependent and malleable process. The exact same cues can lead to contradictory perceptions

across any set of factors, within and between targets, perceivers, and contexts. To only scratch

the surface, individual social perceptions vary across perceiver mood (Maner, Miller, Moss, Leo,

& Plant, 2012; Richards et al., 2002), prejudice (Hess, Adams, Grammer, & Kleck, 2009;

Hugenberg & Bodenhausen, 2004), minimal group identity (Hackel, Looser, & Van Bavel, 2014;

Lazerus, Ingbretsen, Stolier, Freeman, & Cikara, 2016), political affiliation (Krosch, Berntsen,

Amodio, Jost, & Van Bavel, 2013), context (Barrett, Mesquita, & Gendron, 2011; Cuddy et al.,

2009; Hassin, Aviezer, & Bentin, 2013), and culture (Cuddy et al., 2009; Gendron et al., 2014).

Perceptions also vary substantially across perceiver and target demographics, such as race and

gender (Hehman et al., 2017; Oh, Dotsch, Porter, & Todorov, 2017; Sutherland, Young, Mootz,

& Oldmeadow, 2015). Importantly, the organizing structures at the pith of social perception

models (Ekman, 1993; Fiske, Cuddy, Glick, & Xu, 2002; Macrae & Bodenhausen, 2000) also

shift considerably (Stolier, Hehman, & Freeman, 2018). In one notable example, oft-considered

universal dimensions of trait impressions (Fiske et al., 2007), warmth and competence, show

heterogeneity between perceiver and cultural contexts (Cuddy et al., 2009; Sutherland et al.,

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2018; Xie, Flake, & Hehman, 2018).

Furthermore, we now know that ostensibly independent classes of inferences are fundamentally entangled within and between one another, where perceptions of emotion, traits, race, and gender may all mutually elicit and constrain one another (Anderson, Siegel, White, & Barrett, 2012; Hess et al., 2009; Hugenberg & Bodenhausen, 2004; Johnson, Freeman, & Pauker, 2012; Walker & Wänke, 2017). In one example demonstrating these many interdependencies, perceivers tend to categorize ambiguous white/black faces as black if they are expressing anger rather than joy, and this pattern is exacerbated by higher levels of racial prejudice (Hugenberg & Bodenhausen, 2004). In another example, gender information biases trait impressions from faces, where competence cues are negatively related to trustworthiness perceptions in female compared to male faces, presumably due to gender stereotypes associating warmth with submissiveness (Sutherland et al., 2015; Walker & Wänke, 2017). In short, as is apparent, social inferences are anything but fixed. Yet they certainly have ubiquitous commonalities, and often exhibit similar structure across classes and contexts (e.g., the emergence of intentin and ability dimensions in trait impressions from face perception to group stereotypes; Fiske et al., 2007). Thus, how do we begin to integrate such consistency and diversity under one framework?

Conceptual associations shape social inference

For decades in the study of cognition, countless models of memory, language, and perception rely on the general principle that cognitive representations, such as concepts, are stored and retrieved via an associative network of interconnected nodes through which activation spreads (Collins & Loftus, 1975). Modern-day accounts can take many variants of this general principle, from more classic 'spreading activation' associative networks to various forms of connectionist networks, but a set of interconnected representations that become activated as a

function of their cognitive similarity is a shared tenet. Indeed, such accounts are hardly new in social perception and cognition. The idea is implicit in classic theories of social perception, where impressions mutually inform one another and are integrated to represent people (Anderson, 1962, 1965a; Asch, 1946). Moreover, explicit associative and connectionist models have a long history in social perception (Freeman & Ambady, 2011a; Hastie & Kumar, 1979; Kunda & Thagard, 1996; Smith, 1996; van Overwalle & Labiouse, 2004; Zebrowitz, Fellous, Mignault, & Andreoletti, 2003).

Drawing on such domain-general principles of associative processing, I argue that many social perception phenomena, including those we have reviewed, may be parsimoniously explained by a simple network of social concepts associated as a function of their cognitive similarity. People hold rich associative networks of how social concepts are related to one another, for instance, one may associate kindness with competence, positive emotional states, and femininity (Fiske et al., 2007; Rosenberg, Nelson, & Vivekananthan, 1968; Stolier, Hehman, & Freeman, 2018; Tamir & Thornton, 2018). I propose these conceptual maps may be constructed as an associative network, and social perceptions reflect the end-result of spreading activation through this network, a process applied similarly across contexts of social perception (e.g., face impressions, familiar person knowledge, group stereotypes). A major implication of this perspective is that dimensions of social perception previously argued to be fundamental, universal, or fixed due to their pertinence to ever-present adaptive needs or some special cognitive status (e.g., warmth and competence) may simply be the emergent property of the structure of perceivers' social-conceptual knowledge. In other words, such dimensions may arise from the set of associations linking perceivers' learned concepts about the social world and not from any evolutionarily shaped detectors for certain kinds of information. Of course, functional

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adaptations may and likely do drive the structure of social conceptual knowledge too, but the central argument here is that the more proximal mechanism underlying the structure of social perceptions is the structure of social-conceptual knowledge.

Let us consider an example. Imagine two perceivers, each with their own set of social concept associations acquired through their life experiences. The first perceiver has a two-dimensional conceptual network, with little association between concepts of dominance and untrustworthiness. The second perceiver has a mostly unidimensional conceptual association network, where dominance and trustworthiness are inherently linked: others' dominance is associated as untrustworthy while their submissiveness is associated as trustworthy. Perhaps the second perceiver has frequently encountered dominant individuals in their lifetime and learned a covariation between dominance and being cold, apathetic, and untrustworthy, unlike the first perceiver. Each evaluates the same target individual as dominant, whose face provides strength-related cues that consistently elicit this impression (Hehman, Flake, & Freeman, 2015; Toscano, Schubert, Dotsch, Falvello, & Todorov, 2016). Initial activation of dominance impressions will result in cascading activation throughout the perceivers' conceptual networks, in the first perceiver (with a two-dimensional structure) activating impressions associated with dominance but having very little bearing on impressions associated with untrustworthiness. However, in the second perceiver (with a unidimensional conceptual structure), initial activation of dominance impressions will activate conceptually related representations, such as untrustworthiness (e.g., coldness). The contrast in these perceivers' perceptual process has now produced fundamentally different impressions, where the impressions made from identical cues differ between the perceivers, and in turn the dimensional structure of their face impressions is variable rather than static. Importantly, this process is not limited to rotating familiar conceptual structures such as

two-dimensional models (Oosterhof & Todorov, 2008), and may go as far as to produce entirely novel spaces. Any perceiver's conceptual knowledge is the limit. For example, in a hypothetical environment in which dominance is invariant across targets or inconsequential, this perspective holds that dominance may to some extent cease as a representation or dimension activated at all, and other concepts may come to dominate the conceptual and perceptual spaces. Or to be even more hypothetical, a perceiver who has somehow come to conceptualize others primarily along their capacity for humor, or their moral reputation (Brambilla, Rusconi, Sacchi, & Cherubini, 2011) will see the world accordingly. Importantly, the scaffolding of conceptual structure should generalize across classes, such as emotion recognition (Brooks & Freeman, 2018) and social categorization (Stolier & Freeman, 2016), and contexts, such as familiar person knowledge or group-wide inferences (Stolier, Hehman, & Freeman, 2018, June 11). Any classes with conceptual associations (e.g., gender and emotion) should, in theory, be perceived along those conceptual associations (e.g., target happiness tied to the female category) across contexts.

In contrast, functional models of social perception would predict that the two example perceivers would not vary in these perceptions and dimensional structures, given a relatively fixed and adaptively driven perceptual process (Fiske et al., 2007). Or more specifically, such variability would be considered noise or measurement error by such models, not meaningfully produced by the structure of a perceiver's social-conceptual knowledge. Of course, perceivers likely share conceptual structures with some central tendency given their adaptive needs and what common variations in others' personalities are available to be learned (Digman, 1997). However, rather than posit a particular intrinsic structure underlying social perception, holding some special cognitive status due to its adaptive nature, the current perspective is agnostic to any such structure. Instead, I argue that the structure is neither intrinsic or innate, but simply an

emergent property of conceptual knowledge. Whatever set of associations a perceiver harbors about the social world is what will manifest in their social perceptions.

Classic research on implicit personality theory, concerning how perceivers hold lay beliefs about other humans' personalities, spent substantial time measuring perceivers' conceptual associations between traits. Seminal work in trait impression structure measured the correlations of participants' perceptions of acquaintances (Rosenberg et al., 1968). A long line of research then described how perceivers hold rich conceptual structures of how personality trait concepts correlate (e.g., 'Are kind people likely to be smart?'; Schneider, 1973). Initial trait impressions were found in part to derive from these structures, as informed by other parallel trait impressions of a target (e.g., 'this kind person is probably smart'; Asch, 1946; Ebbesen & Allen, 1979). Researchers went further to question whether conceptual structure varied between perceivers (Hamilton, 1970) or individual differences in impression structures derived from perceiver group membership and stereotypes (Hirschberg, Jones, & Haggerty, 1978; Secord & Berscheid, 1963). However, with the emergence of ecological approaches to social perception and an increasing focus on face perception in social cognition (McArthur & Baron, 1983; Zebrowitz et al., 2003), interest in implicit personality theory waned. Instead, interest grew in how affordances of social stimuli communicate functionally relevant information to perceivers (Zebrowitz & Collins, 1997) and in more bottom-up, fixed approaches in general (Fiske et al., 2007). The current research aims to help bridge the more classic work on implicit personality theory and top-down influences of conceptual knowledge with the current issues facing social perception researchers today.

The present research

To initially explore the role of conceptual associations in guiding social inference, I

examine a clear tell of this process: correlations in social inferences should reflect associations between the social concepts being inferred. If we associate the concepts of happiness and femininity, feminine faces should activate perceptions of happiness, and happy faces of femininity. If we associate kindness with creativity, kind faces, friends, and social groups should be perceived as creative alike. Furthermore, perceivers who vary in conceptual associations should show corresponding differences in their perceptions, for instance, one who instead believes kind people are not creative should not ascribe creativity to kind faces, friends, and social groups. Here I explore just this, evaluating whether perceptions of specific social features, broadly construed, are interdependent along the lines of their underlying conceptual associations. This is an important starting point, as it evaluates large-scale assumptions of this perspective at a bird's eye view, therefore also allowing us to begin with assessments of its generality across perceptual classes (e.g., emotion, personality traits, social categories) and contexts (e.g., face impressions, familiar person knowledge, group stereotypes).

In this dissertation I address this overarching question in three chapters, providing both recently published research (in Chapters 1 and 3; Stolier & Freeman, 2016; Stolier, Hehman, Keller, Walker, & Freeman, 2018), and more recent unpublished research (preprint available at https://psyarxiv.com/5na8m; Stolier et al., 2018, June 11). Given the span of this dissertation across several distinct articles, the findings are discussed from several approaches. However, each contributes directly to the perspective I propose, providing convergent evidence for a social perception shaped by perceivers' conceptual associations. In Chapter 1, I examine how conceptual associations underlie face-based trait impressions (Stolier, Hehman, Keller, et al., 2018). In Chapter 2, I explore how such conceptual associations are applied similarly across social perceptual contexts, from face impressions, to familiar person knowledge, to group

stereotypes (Stolier et al., 2018, June 11). Lastly, in Chapter 3, I examine how conceptual

associations guide other classes of social perception, namely emotion recognition and social

categorization from faces (Stolier & Freeman, 2016).

CHAPTER 1

Preface

In Chapter 1, I apply my perspective to face impressions, testing whether perceivers' face impressions are mutually bound by their conceptual associations, such as whether perceivers use information about certain traits perceived in a face (e.g., kindness) to infer other traits (e.g., creativity; Stolier, Hehman, Keller, et al., 2018). This would entail that face impressions are consequence of perceivers' subjective concept association networks, and their dimensional structure is dynamic rather than static. In Study 1, I measured how related personality traits are to one another in both conceptual associations and face impressions, on average across perceivers. I found that trait-pairs believed to be more correlated (e.g., 'kind people are likely to be intelligent') are more correlated in face impressions (e.g., kind faces are judged as intelligent). Studies 2 and 3 found individual differences in the application of conceptual associations, where perceivers who believed two traits were more related perceived those traits more similarly in faces (e.g., judged kind faces to be more or less intelligent based upon their conceptual association). The results of these experiments suggest perceivers apply their trait conceptual associations to face impressions. Importantly, this may explain how people are able to infer the gamut of traits from faces (e.g., creativity) from lower-level trait impressions made from the faces (e.g., kindness), and highlights a key source of individual variability in in face impressions. Thus the application of conceptual maps is especially fruitful in the context of face impressions. This is an important extension of existing theoretical accounts of face impressions, which do not account for considerable individual differences (Hehman et al., 2017), and only explain the psychological origins of several core impressions (e.g., trustworthiness, dominance; Zebrowitz & Montepare, 2008). Furthermore, this may explain the origins of dimensions in models face

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impressions (Oosterhof & Todorov, 2008), which emerge as a consequence of the dimensional organization of conceptual networks.

Chapter 1 is available as published in Stolier, Hehman, Keller, et al. (2018).

Stolier, R. M., Hehman, E., Keller, M. D., Walker, M., & Freeman, J. B. (2018). The conceptual structure of face impressions. *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.1807222115

CHAPTER 2

Preface

In Chapter 2, I detail a set of studies aimed to assess how social concept association networks are applied across different contexts of trait impressions, ranging from face impressions, to familiar person knowledge and group-level stereotypes (Stolier et al., 2018, June 11). In Study 1, I measured how related, on average across perceivers, traits are to one another in conceptual associations, and trait impressions of faces (of strangers), familiar people (e.g., Barack Obama), and social groups (e.g., lawyers). I found that traits with stronger conceptual associations are more associated alike in social perceptions across each perceptual context. If perceivers apply their conceptual networks to impression formation, impressions should vary across perceivers in line with individual differences in their associative networks. In Study 2, I reassess the questions of Study 1 using different trait descriptors for each model (e.g., in the conceptual model we measure the item 'friendliness', then in impressions the item 'how likely are they [a target] to compliment others?'), circumventing semantic confounds and grounding these findings in perceiver conceptions of traits as relating to substantive cognitive and behavioral dispositions of others. In Study 3, I test whether participants who conceptually associate traits more or less are more or less likely to infer those traits together in social perception. In Study 4, we manipulate perceiver conceptual associations between traits to test their more direct impact on face impressions and their associations. Together, these studies are intended to highlight how conceptual associative networks are similarly applied across perceptual contexts by perceivers.

Chapter 2 is available as it appears in preprint (available at https://psyarxiv.com/5na8m)
in Stolier et al. (2018, June 11).

Stolier, R. M., Hehman, E., & Freeman, J. B. (2018, June 11). Conceptual structure shapes a
common trait space across social cognition. doi:https://doi.org/10.31234/osf.io/5na8m

CHAPTER 3

Preface

In Chapter 3, I broadly explore how conceptual associations between emotion, gender, and race categories shape their perception from faces, and how this process unfolds in the brain (Stolier & Freeman, 2016). This suggests ostensibly fixed and independent social categorizations are in fact dynamically construed via perceivers' social concept associative networks. In two studies, participants viewed faces varying along dimensions of emotion, gender, and race. I measured the similarity of social categories in their conceptual content, face perceptions, and neural pattern responses during functional magnetic resonance imaging. Computer mouse-tracking revealed social categorizations were bound together along the lines of their conceptual associations, for instance where participants temporarily were drawn towards the 'angry' response option before the final selection of the correct 'happy' response option, to the degree they conceptually associated the 'anger' and 'black' categories. The conceptual binding of these categories was also evident in neural response patterns in brain regions involved in face perception. Right fusiform gyrus voxel patterns of different categories (e.g., angry, black) were similar to one another to the extent those categories shared conceptual associations. These findings suggest conceptual associations additionally bias both emotion recognition and social categorization.

Chapter 3 is available as published in Stolier and Freeman (2016).

Stolier, R. M., & Freeman, J. B. (2016). Neural pattern similarity reveals the inherent intersection of social categories. *Nat Neurosci, 19*(6), 795-797. doi:10.1038/nn.4296

GENERAL DISCUSSION

This research provides a broad foundation for understanding social perception as a process grounded in perceivers' subjective social-conceptual associations (Stolier, Hehman, & Freeman, 2018). In Chapter 1, several experiments found face trait impressions guide one another to the extent traits inferred are conceptually associated, for example where agreeable faces are seen as open-minded to the extent perceivers believe agreeable people are likely to be open-minded (Stolier, Hehman, Keller, et al., 2018). In Chapter 2, conceptual associations were found to shape inferences across the many contexts of social perception, including face impressions, familiar person knowledge, and group stereotypes (Stolier et al., 2018, June 11). In Chapter 3, behavioral and neuroimaging studies found conceptual associations underlie and bind the social perceptual classes of emotion recognition and social categorization processes as well (Stolier & Freeman, 2016). For instance, perception of face gender was shaped by both race and emotion expression in line with these concepts' associations. Chapters 1 and 3 demonstrate that the variety of social inference classes have a conceptual basis (e.g., emotion recognition, social categorization, and trait impressions). Chapter 2 demonstrates conceptual structures are similarly applied across different contexts of social perception. Each study provides evidence for conceptual scaffolding of social perceptions and their emergent dimensional structure.

Together, these findings suggest conceptual associations are an integral and guiding force in social inference. I have proposed that social perceptions, like many other cognitive phenomena, can be conceived as the end-result of spreading activation through associative networks of social concepts. Recent trends in social perception theory are largely bottom-up, where functional accounts suggest perceivers track a relatively fixed set of adaptively significant features of others (Ekman, 1993; Fiske et al., 2007; Macrae & Bodenhausen, 2000). Departing

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from these views, here I suggest social perception is instead a direct consequence of domain-general associative processing, and its structure will therefore take on the form of any individual perceivers' baseline or momentary conceptual knowledge. While functional considerations certainly speak to how humans prioritize and organize conceptual knowledge about social attributes (e.g., sadness, friendliness, competence, male), the mechanism at play in social perception, I argue, is agnostic to what shapes conceptual knowledge in the first place.

An important contribution of this perspective is its parsimony as an integrative framework spanning the many contexts of social perception. The proposed use of social concepts and their associations in social inference spans both inference class (emotion recognition, social categorization, trait impression) and context (face perception, familiar person knowledge, and group stereotyping). This entails a single perceptual process operating similarly across these cases, therefore providing similar predictions universally for any given perceivers' social concept network. Integrative frameworks are indeed present in many corners of social perception research, such as in the cases of implicit personality theory (Schneider, 1973), face-based perceptions (Freeman & Ambady, 2011a), mental state inference (Tamir & Thornton, 2018; Waytz, Gray, Epley, & Wegner, 2010), and trait impressions (Fiske et al., 2007). Several of these cases have to some degree argued or implied a similar concept associative process involved in social perception, such as recent models of social categorization (Freeman & Ambady, 2011a) and mental state inference (Tamir & Thornton, 2018). The perspective I advocate here is influenced by these and prior theory (Schneider, 1973), however aims to more comprehensively define a domain-general process across any form of social perception.

Implications

Given its breadth, this process should be extended to account for many prominent effects

observed in the social perception literature, which may be conceived as a product of spreading activation through social-conceptual networks. One prominent question in impression formation is that of centrality of specific impressions (Asch, 1946), such as morality as a guiding concept of valence dimensions (Brambilla et al., 2011). Research may assess whether concepts central in perceivers' conceptual associative networks underlie centrality in perceptions. Primacy effects, where earlier impressions bear larger weight than later impressions, may also be approached from a perspective of initial concept activations restraining or precipitating activation of concepts later inferred (Anderson, 1965b). There is also the question of why negative information is often a primary guiding force in perceptions (Anderson, 1965a), where we may predict its dominance due to the centrality and probabilistic strength of negative concepts in perceivers' conceptual maps. Importantly, the research we have presented implies important individual differences exist due to variant conceptual structures, and they should be explored across these many effects.

Related, the perspective proposed here has implications for research into the updating of perceptions and impressions. Perceptions vary substantially in their malleability (Mende-Siedlecki, Baron, & Todorov, 2013; Skowronski & Carlston, 1987), and this may in part be due to the nesting of specific concepts within clusters of other concepts. A concept conceptually bound by many other impressions of a target may be more difficult to update. For example, if a perceiver associates honesty with extroversion and kindness, it may be more difficult to update honesty impressions of an extroverted and kind target, whereas a perceiver without this association may more easily update the impression. In the context of stereotyping, one domain this process may inform and extend is individuation (Fiske & Neuberg, 1990), where conceptual maps may be applied more often when diagnostic information is absent (e.g., assuming an outgroup or honest target is extroverted), compared to when it is present or sought out (e.g.,

knowing that independent of an honesty-extroversion association, a familiar individual is honesty but introverted). Evidence has begun to illuminate this as the case, for instance where conceptual trait models explain more variance towards unfamiliar compared to familiar others (suggested in a glance of Study 3 in Chapter 2, Fig. 2.4; also, see Thornton & Mitchell, 2017). These effects of course are countless in number (Uleman & Kressel, 2013), and it will be important to enumerate them and consider where and when the current perspective may be informative.

The process I have described also may contribute considerably to the study of successful and adaptive social inference. It is well documented that human personality traits are highly intercorrelated, for example in the big five factors of personality (Goldberg, 1993). This implies that a perceiver's learned knowledge of this structure in conceptual associations may allow a clever route to accurate impressions. Research has indeed found the structure of conceptual associations to substantially reflect that of actual personality (Lay & Jackson, 1969). As further evidence, recent work has found perceiver conceptual associations between emotion concepts allow accurate prediction of others' emotional states (Thornton & Tamir, 2017). For this reason, the application of conceptual associations has recently been proposed as central to mental state inference (Tamir & Thornton, 2018). A similar approach could be further applied across the spectrum of social inferential processes, investigating how conceptual structures contribute to accuracy, or alternatively error, from trait impressions to social categorization.

Additionally, this perspective highlights a solution to an often underappreciated problem facing the social perceptual process: the prevalence of ambiguous, noisy, and sparse information, regardless of the perceptual domain (Brunswik, 1956), and the use of conceptual associative structures to account for this issue and efficiently make any social inference. The use of conceptual associations to fill in the blanks or connect the dots here is by no means a novel idea

(Asch, 1946). In domains where the obvious problem is limited information, such as trait inferences of unfamiliar category members (Allport, 1954; Devine, 1989; Fiske & Neuberg, 1990; Gilbert & Hixon, 1991; Macrae & Bodenhausen, 2000) or inference of often elusive mental states (Koster-Hale & Saxe, 2013; Tamir & Thornton, 2018), social-conceptual associations are a guiding principle of social inference. However, although with notable exceptions, models of emotion recognition, social categorization, and impression formation are largely bottom-up, focused on how inferences (e.g., 'black') arise from cues that directly inform them (e.g., skin pigment) and are available to the perceiver (Brewer, 1988; Hamilton, Katz, & Leirer, 1980; Macrae & Bodenhausen, 2000; Trope, 1986). These theories therefore provide little in the way of explaining inferences less directly tethered to the stimulus, which the current perspective easily accounts for across domains of social perception.

Novel predictions and future directions

A major contribution of this research is the scope of novel predictions made by its perspective. An important next step for this perspective is its formalization computationally as a connectionist model (McClelland et al., 2010). The process I have described may be accounted for by a simple two-layer neural network model. Stimuli could be represented in a feature layer, in which any set of feature nodes may be present given the specific perceptual context (for instance, the node could pertain to specific facial features, such as a nose width, or even words overheard in conversation, such as 'arrogant'). This first layer of stimulus features would then reach through stimulus-concept weights out to a second layer, in which laterally connected nodes represent the perceiver's associative network of social concepts (e.g., the association of 'dominance' positively with 'arrogance' and negatively with 'warmth). Stimuli presented to the perceiver would activate feature nodes, which in turn elicit cascading activation throughout the

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conceptual layer, instantiating the process I have discussed. While much future work is needed to implement and test such a model, once formalized there are several theoretical predictions it would generate. The problems we face in research of social perception may benefit immensely from this approach, where single models may provide predictions across the many facets of a process, for instance, social concepts' initial formation, temporal dynamics, variance, and dimensional structure (Conrey & Smith, 2007; Freeman & Ambady, 2011a; Kunda & Thagard, 1996; Read & Miller, 1998a, 1998b; Rumelhart, Hinton, & McClelland, 1986; Smith & DeCoster, 1998).

First, let us consider how such a model could inform initial perceptions. A face may hold features that activate an initial set of inferences most directly associated with those features (e.g., strength, emotion, and gender inferences; Abir, Sklar, Dotsch, Todorov, & Hassin, 2018; Zebrowitz & Montepare, 2008). Initial activations then cascade dynamically throughout the network of social concept nodes, eliciting or inhibiting other concepts already directly activated from the external factors (e.g., inferences more loosely related to features, e.g., 'creativity'), or indirectly activating concepts not yet in motion through their conceptual associations (e.g., activating 'gun owner' in association with a more proximal activation of 'dominance' via strength cues). (This process may therefore help explain how perceivers can go so far as to suppose family history, religion, or gun ownership from mere facial cues that are unlikely to have direct associations with the encyclopedia of social attributes; Olivola & Todorov, 2010; Rule & Sutherland, 2017). The presence of weighted edges between nodes may allow us to incorporate and account for asymmetries in associations between traits where they exist.

Second, we can make specific inferences about the dynamics of the social inferential process. Much like in the case of recent social categorization models (Freeman & Ambady,

2011a), cascading activity across a conceptual associative network means specific concepts activate at different timescales and with variant ease. For instance, if unfriendliness is closely associated with anger and male concepts, it will be more readily inferred from those cues than more distal concepts such as egotism. This means that generally, inferences more directly associated with cues will be processed with more ease and automaticity, such as dominance inferences from strength cues (Abir et al., 2018). This may help explain why impressions more invariant between perceivers are made with more ease (perhaps due to their more immediate stimulus associations), whereas those impressions that vary between perceivers are made with less ease (presumably due to lengthier associative paths necessary to activate them, which will inherently vary more between perceivers; Hehman et al., 2017). This therefore may speak to the question of automaticity and varying levels of accessibility in social inference across contexts, such as in the cases of automatic face impressions (Bar et al., 2006; Todorov et al., 2009; Willis & Todorov, 2006), spontaneous trait inferences (Uleman, Newman, & Moskowitz, 1996; Winter & Uleman, 1984), and automatic stereotyping (Devine, 1989; Gilbert & Hixon, 1991).

Third, important individual differences are predicted by this perspective, to the extent perceivers vary in their conceptual associations between social information. A substantial proportion of social inference variance is due to perceiver characteristics (Hehman et al., 2017; Xie et al., 2018). Perceivers who believe two concepts are more related (e.g., trustworthiness positively related to competence) will use information about either trait to infer its associate (e.g., competent appearance or display elicits trustworthiness inference; Stolier, Hehman, Keller, et al., 2018). Such individual differences are crucial to the study of social behavior, as they predict differential social interaction and even group-based discrimination where conceptual structures vary. For instance, we may predict a demographic of voters who associate competence

with warmth are more likely to elect politicians whose faces resemble the happy emotional expression at rest (Said, Sebe, & Todorov, 2009; Zebrowitz & Montepare, 2008), in contrast to primarily utilizing competence cues (Todorov et al., 2005). This prediction is perhaps at play in prior research that found differential face impressions sometimes contribute to leadership roles, such as warmth cues to non-profit CEO positions (Re & Rule, 2016) and babyfacedness to CEO positions for African Americans (Livingston & Pearce, 2009).

Lastly, as we have frequently discussed, such a model makes important surface level predictions about the correlation structures of social inferences, which are the language of prominent models of social perceptual processes. Dimensional models of social perception are wide-spread, present in mental state inference (Gray et al., 2007), emotion (Russell, 1980), face impressions (Oosterhof & Todorov, 2008), person knowledge (Rosenberg et al., 1968), and stereotypes (Fiske et al., 2002). These models are analyses of the correlation structure of the many social inferences they aim to explain. If these correlation structures emerge due to the application of conceptual associations to social inference, we can provide integrated predictions about model structures across contexts. Importantly, we can highlight that these models should vary to the extent conceptual associations applied to perceptions vary (Stolier, Hehman, & Freeman, 2018), which may explain why disparate models are unearthed year after year, such as in mind perception (Tamir et al., 2016; Weisman, Dweck, & Markman, 2017), face impressions (Vernon et al., 2014; Xie et al., 2018), and stereotyping (Koch et al., 2016). This would suggest that research intended to identify any one universal model are misguided.

Conclusion

In summary, here I have provided evidence for a conceptually shaped social perceptual process. The work presented here suggests that, rather than a set of fixed mechanisms for picking

up on functionally adaptive information about others, a dynamic structure for social perception

emerges out of a perceiver's learned conceptual associations about the social world. In the future,

I hope this perspective can ultimately help move us toward a more integrative framework in the

ever-growing world of social perception research.

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