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REVISED How cognitive processes shape implicit stereotypes: a literature review

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Abstract

Stereotypes are fundamental to social cognition, representing the automatic associations and evaluations individuals hold about social groups. Their automatic activation, characterized by rapid and often unconscious processes, makes them resistant to change and persistent across contexts. However, evidence shows that motivated individuals can modulate these processes under certain conditions. This essay explores the mechanisms underlying stereotype formation and maintenance, integrating Clark's predictive brain model and Hinton's culture in mind framework to examine how cognitive and cultural factors interact. The predictive brain framework suggests that human cognition operates on Bayesian principles, using prior experiences to predict and interpret stimuli. This aligns with the culture in mind perspective, which emphasizes how cultural norms shape cognitive processes, including stereotypes. These models illustrate how stereotypes arise from the dynamic interplay between individual cognition and broader cultural influences. Key modulators of stereotypes include decision-making, emotion regulation, and motivation. Decision-making often relies on implicit processes, where automatic associations influence behaviour outside conscious control, but neural systems can regulate these effects. Emotional regulation, through the management of arousal levels, can influence the cognitive application of stereotypes, potentially reducing their impact. Motivation drives selective stereotype use, shaped by personal goals and cultural expectations. Understanding the cognitive and cultural roots of implicit stereotypes is crucial for designing effective interventions to reduce inequalities and promote equity in educational, occupational and social contexts, and the cross-sectional approach allows us to understand how different forms of

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discrimination intersect with each other to reinforce inequalities and strengthen deep-rooted prejudices. This essay advances an integrated theoretical framework that conceptualises implicit stereotypes as probabilistic cognitive constructions shaped and continuously updated through cultural contexts. It outlines how this integration provides a basis for addressing inequalities across educational, occupational, and social domains.

Plain Language Summary

This paper reviews research on how our thinking and cultural background contribute to the creation and persistence of implicit stereotypes, automatic, often unconscious beliefs about groups of people. Drawing on two key theories, the predictive brain model by Andy Clark and the culture in mind framework by Perry Hinton, the paper explores how individual cognitive processes and cultural influences work together to shape dominant ideas about social groups. By combining insights from cognitive and social psychology, the essay highlights how both personal experiences and the broader social environment interact to form and sustain stereotypes. It also examines how different types of discrimination—such as those based on gender, race, or other identities—overlap and reinforce each other, creating stronger inequalities. Understanding these dynamics is essential for developing strategies to reduce bias and promote fairness in schools, workplaces, and society. The findings contribute to ongoing discussions about improving intergroup relationships and building a more inclusive world, calling for innovative approaches to challenge and dismantle deep-rooted stereotypes.

Keywords

stereotypes, predictive brain, culture in mind, cognitive processes



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REVISED **Amendments from Version 2**

This new version of the essay strengthens both its theoretical clarity and its practical relevance.The initial version provided a broad and integrative discussion of cognitive and cultural mechanisms underlying implicit stereotypes, while the current manuscript offers a more explicit articulation of its central aim and contribution. The essay now frames stereotypes as probabilistic and predictive cognitive constructions that are continuously shaped and updated through cultural contexts. A key improvement is the clearer positioning within contemporary literature: recent developments in research on implicit bias, predictive processing, and cultural cognition are now more extensively discussed and they better reflect current academic debates, by highlighting the dynamic and context-dependent nature of stereotype formation and change. The revised version expands its applied dimension by explicitly addressing how the proposed framework can inform strategies to reduce inequalities. A new section is dedicated to exploring implications across educational, occupational, and broader social contexts, linking cognitive processes (attention, motivation, and emotion regulation) with structural and cultural interventions. This addition aims to bridge theoretical insights with real-world applications, emphasizing that meaningful change requires coordinated action across individual, institutional, and cultural levels.

These revisions enhance the coherence, relevance, and impact of the essay, transforming it from a primarily theoretical reflection into a more comprehensive framework that connects cognitive and cultural analysis with concrete pathways for addressing social inequalities.

Any further responses from the reviewers can be found at the end of the article

Introduction

Since their first conceptualization, stereotypes demonstrated to be key determinants of social cognition, thus representing the semantic associations and evaluation people hold on social groups. Central to their understanding, is the key concept of "automatic" activation of stereotypes, reflecting an inherent resistance to change and an invariance across contexts. This automaticity, defined as the rapid, parallel, and largely uncontrollable nature of these processes, contrasts with the slower, conscious and effortful nature of controlled processing (Kahneman, 2013). Yet, data from several studies suggest that motivated individuals can modify these processes within different situation. For instance, it has been shown that individual with threatened self-images may activate negative stereotypes to strengthen their self-esteem, or to discredit evaluators they dislike, whilst the opposite can happen if it benefits their self-image (Sinclair & Kunda, 1999; Spencer *et al.*, 1998; Spencer *et al.*, 2016). Stereotypes are driven by several motives, such as the needs for belonging, understanding, self-enhancing, trusting and controlling. Hence, automatic attitudes are not as rigid as formerly thought and can be quite responsive to the perceiver's situational motives.

Stereotypes function as expectations and shape information processing: easily processing stereotype-consistent information and inhibiting inconsistent information through the directing of attention (Hamilton *et al.*, 1990; Sherman *et al.*, 2005). A much-debated question is whether attention plays a crucial role in the activation and inhibition of stereotypes: when perceivers are unable or unwilling to pay attention to a target, stereotyping becomes more likely, leading to biased judgment and behaviours. However, it also suggested that a lack of attention can reduce automatic stereotypes, thereby decreasing the likelihood of stereotypic judgments (Fiske & Neuberg, 1990; Fiske & Taylor, 2021; Gilbert *et al.*, 1998).

Existing research recognizes the critical role played by the diverse strategies (e.g., suppressing stereotypes, expecting counter-stereotypic events) in significantly affecting the automatic activation of stereotypes, and their capability in leading to longer-term changes (Dasgupta & Greenwald, 2001; Kawakami *et al.*, 2000). Counter-stereotypes can produce systematic responses even in the presence of high cognitive constraints that compete with automatically activated stereotypes (Blair & Banaji, 1996; Gilbert & Hixon, 1991; Macrae *et al.*, 1997; Metcalfe, 1998). It has been argued that the conscious and intentional creation of mental representation (i.e., mental imagery) can influence cognitive, emotional and behavioural responses (Dadds *et al.*, 1997; Kosslyn, 2005; Taylor & Schneider, 1989). Mental imagery has been effective in altering judgments and behaviours across various domains, suggesting its potential for modifying implicit stereotypes. Implicit and explicit attitudes are often associated, due to shared roots in personal and cultural experiences. However, the automatic activation of stereotypes can occur independently of personal beliefs, leading to potential conflicts between implicit responses and consciously held egalitarian views (Devine, 1989). Recent research has further emphasized the context-dependent and dynamic nature of implicit bias, suggesting that such biases are not fixed traits but are constructed in response to situational and cultural inputs (Forscher *et al.*, 2019; Payne *et al.*, 2017). These findings challenge earlier assumptions of stability and highlight the importance of considering both cognitive and environmental factors in understanding stereotype activation and change.

Understanding the dynamics of stereotypes requires an integrated approach that considers both cognitive processes and cultural influences. This essay will explore the mechanisms by which automatic stereotypes might be modified, emphasizing the roles of decision-making, emotion regulation, motivation, and cultural context, considering Clark

(2012); Clark (2013); Clark (2018) and Hinton (2017) contributes through the "predictive brain" and the "culture in mind" perspectives. By doing so, the essay not only synthesises existing theoretical perspectives but also proposes a novel interpretative lens that links cognitive mechanisms and cultural dynamics to explain both the persistence of stereotypes and the conditions under which they can be effectively modified.

"Predictive brain" and "culture in mind" perspectives

In the study of the cognitive aspects related to the processes of constructing and maintaining implicit stereotypes, two significant perspectives can contribute to the understanding of how the mind operates and processes information within cultural contexts: the "Predictive Brain" framework proposed by Clark (2013) and the "Culture in Mind" concept, discussed by Hinton (2017). These two approaches offer valuable insights and perspectives into the functioning of stereotypes by emphasizing their cognitive rather than social aspects and help understand how stereotypes are formed, maintained and potentially changed within individuals and across societies.

According to the "Predictive Brain" (Clark, 2012; Clark, 2013), human brain constantly makes predictions about the world, through Bayesian principles, based on prior experiences and learned associations. This model suggests that brain functions as a probabilistic machine, continually updating beliefs and expectations to minimize errors in perception and decision-making. Hence, brain bases its prediction on the likelihood of events occurring as observed in the real world, not necessarily on what is socially desirable or morally correct. This modular view of the brain and cognitive functions emphasizes the role of inference in perception, suggesting that what we perceive is strongly influenced by our prior beliefs and expectations. From this perspective, it can be explained how preconceived notions about social groups can influence perception and behaviour: stereotypes, as predictive models, lead to expectations and interpretations about certain groups that can perpetuate discriminatory behaviour. Since the brain's predictive mechanism operates largely outside of awareness, these cognitive biases are not always conscious. Therefore, even when individuals consciously reject certain stereotypes, these may persist at an implicit level, since the brain continues to rely on those learned associations that have proven to be statistically common in their social context. Considering this perspective, implicit stereotypes cannot be considered just cognitive biases or errors in judgment, but, rather, they are the natural outcome of the brain's effort to predict social interactions based on the most common and consistent information in encounters. Therefore, stereotypes form because the brain unconsciously identifies patterns from the social world and interprets these patterns as reliable predictors of behaviour o traits associated to a certain group. This learning process is often unconscious and driven by the brain's need to make sense of the social environment efficiently.

The "Culture in mind" framework (Hinton, 2017), emphasizes the role that culture has in shaping cognitive processes, including the development and perpetuation of stereotypes. Culture acts as a source of shared knowledge and common understandings that influence how individuals think, feel and behave. In this view, implicit stereotypes should be understood as manifestation of broader cultural patterns and norms that are internalized by members of a cultural group. This concept suggests that stereotypes are culturally constructed and maintained through communication, socialization, and media, embedded in the narratives, symbols and practices of a society and transmitted through generations as part of the cultural knowledge that individuals acquire. Therefore, implicit stereotypes are constantly being reshaped by changes in cultural norms, media representations and social interaction, as they are the cultural product of values, beliefs and power dynamics of the society in which they arise. Hence, it is not possible to change implicit stereotypes without addressing the cultural context that sustains them.

The notion of "culture in mind" suggests that cultural factors are deeply embedded in cognitive processes. Through an enactivist perspective, Hinton argues that there is an interpenetration between culture and cognition that makes them inseparably intertwined (Hipolito & Kirchhoff, 2019; Hutto *et al.*, 2020; Safron *et al.*, 2022). To look at stereotypes from this perspective is to recognize the cultural narratives and social norms that form and shape the cognitive schemas that individuals use to interpret the world. Stereotypes thus become cultural constructions of mental representations that are perpetuated through social interactions and the media. The prevalence of stereotypes can be traced back to historical and cultural narratives that have been reinforced over time and understanding this cultural permeation means recognizing that stereotypes are not just individual cognitive errors, but part of a broader cultural phenomenon. This recognition is fundamental to addressing the systemic nature of stereotypes and their impact on social equality.

When considering these two perspectives together, it becomes evident that stereotypes are the product of both cultural influences and predictive cognitive processes. Taken together, these theories demonstrate how difficult it is to deal with stereotypes because it requires altering social constructs as well as internal mental mechanisms. However, combining "Predictive Brain" and "Culture in Mind" frameworks may offer a more comprehensive understanding of how stereotype function: on one hand we find the cognitive mechanisms by which stereotypes are learned and maintained at an unconscious level, on the other hand, we remember to emphasize the role of cultural and social factors in shaping these

cognitive processes. Culture is not monolithic or fixed, but rather a dynamic interaction between individuals and their cultural context. People actively construct their social world and media environment, which means that implicit stereotypes are constantly being updated to reflect both stable cultural patterns and evolving social norms. This perspective highlights the importance of consistent exposure to counter-stereotypical information in undermining negative implicit stereotypes. Recent developments in predictive processing approaches further emphasize the role of socio-cultural environments in shaping cognitive priors, suggesting that perception and social cognition emerge from continuous interactions between brain, body, and environment (Durt *et al.*, 2017; Frosch *et al.*, 2022).

The role of decision-making in stereotypes

Social psychology extensively studied stereotypes as simplified generalizations about groups. One of the most well-known tools for assessing implicit stereotypical associations is the Implicit Associations Test (IAT); this instrument has demonstrated that implicit stereotypical associations can influence social judgment even among those who consciously aim to avoid such biases, raising significant questions about both the control over and the individual's responsibility for implicit stereotype effects that they consciously reject. The concept of implicit stereotypical association is underpinned by two theoretical constructs: associative networks in semantic memory and automatic activation. Kahneman's (2013) dual-system theory assumes that conscious processing is slow, effortful, and requires attentional resources and motivation, while the automatic processing is rapid, operates outside of conscious awareness and involves parallel processing. Stereotypical associations, which are learned from culture and socialization, are automatically activated upon encountering a member of the stereotyped group, thus activating the automatic processing which can influence the perceivers' thoughts and behaviour, often bypassing conscious intentions to inhibit prejudicial responses. This mechanism is facilitated by the implementation of heuristics, simple decision-making principles based on recognition or familiarity. Several studies demonstrated the efficacy of heuristics across various fields, such as economics, emergency medicine and consumer (Gigerenzer & Gaissmaier, 2011) behaviour; working by exploiting prior probabilities and, consequently, reducing the cognitive load required for each new decision. This concept has been extended to social perception by Clark (2013) arguing that the "Predictive Brain" employs similar mechanisms in processing social information. This framework has been further applied by Otten *et al.* (2017) to social knowledge, suggesting that perception, including social perception, involves the application of learned probabilities to new experiences.

Despite the widespread use of the IAT and the focus on implicit stereotypes as a dominant framework in contemporary psychology (Fiske & Taylor, 2021), the predictive validity of this instrument in revealing unconscious biases has been challenged (Oswald *et al.*, 2013). In fact, stereotypes, rather than indicating unconscious cognitive biases, seems to reflect associations learned from cultural information. These association, according to the predictive brain model, are probabilistically detected and a product of the normal brain functioning in life. Hence, implicit stereotypes evolve as cultural norms evolve, though at a slow pace for some associations. The predictive brain model emphasizes the need to integrate cognitive research with cultural dynamics to truly and fully understand the nature of implicit stereotypes. More recent models of implicit cognition have also questioned the stability and predictive validity of implicit measures, proposing that implicit evaluations emerge from multiple interacting processes that are sensitive to contextual variation (Gawronski, 2019). This perspective aligns with the predictive brain framework, reinforcing the idea that social judgments are constructed dynamically rather than retrieved as fixed associations.

According to Devine (1989), since stereotypes are culturally shared, they can be automatically triggered; therefore, those with positive attitudes toward a social group may also trigger negative stereotypes if they encounter a member of that group. This is also supported by the evidence that implicit attitudes, as a possible result of internalized explicit attitudes (Brauer *et al.*, 2000), are influenced by individual and cultural experiences (Dovidio *et al.*, 1997). Decision-making processes then become implicit, triggered by the strongest learned implicit stereotypical associations. Research on cognitive neuroscience supports the existence of early control mechanisms that may operate without conscious awareness (Berns *et al.*, 1997; Nieuwenhuis *et al.*, 2001). Two neural systems are involved and work in concert to produce intended behaviour despite the conflicting tendencies: a conflict-detection system, associated with the anterior cingulate cortex, and a regulatory system for response regulation, linked to the prefrontal cortex (Botvinick *et al.*, 2001; Gehring & Fencsik, 2001; MacDonald *et al.*, 2000).

The role of emotion regulation in stereotypes

Among the most interesting and least studied cognitive aspects in the formation and expression of stereotypes is the role of emotional regulation, i.e. the process of individual perception, modification and experience of emotions. Emotions, as primary variables, can play an important role in controlling the expression of implicit stereotypes. However, most research to date has focused on the effects stereotypes have on mood states. Several studies focused on how emotional regulation strategies change the effects of stereotypes on stigmatised groups. Rumination appears to be a significant mediator between stigma-related stress and psychological distress that increases as rumination increases, indicating a

causal role (Hatzenbuehler *et al.*, 2009). It would also appear that emotional suppression might be a strategy that leads to more positive emotions being experienced in people with high levels of prejudice than the non-use of emotional regulation strategies and leads to an increased desire for intergroup contact, whereas this is not the case in people with low levels of prejudice (Burns *et al.*, 2008).

Why then focus on the role of emotional regulation? Cognitive performance - including decision-making, motivation and thinking, which regulate the implicit application of stereotypes - is influenced by the levels of arousal experienced (Johns *et al.*, 2008). According to studies (Hatzenbuehler *et al.*, 2009; Johns *et al.*, 2008), optimal cognitive performance occurs at moderate levels of arousal, whereas high emotional arousal may enhance as much as impair the cognitive processes underlying implicit stereotype use. Current research suggests that while emotions may reinforce the cognitive persistence of stereotypes, the use of emotion regulation strategies may have the potential to moderate or even counteract this influence. From a predictive processing perspective (Clark, 2013), emotion regulation can be interpreted as a hierarchical process of minimising prediction errors, regarding interoceptive and social signals. Emotions serve as feedback indicators of mismatches between expected and actual sensory states, and regulation strategies function as top-down predictions aimed at restoring equilibrium. Considering this framework, stereotypes my persist because they provide stable and low-cost predictions about social interactions, reducing uncertainty. However, we should consider that engaging in emotion regulation strategies (reappraisal or perspective-taking) allows to generate new predictive models that reinterpret incoming social information; meaning that, potentially, we could reduce the precision of stereotypical assumptions. Emotion regulation is not merely reactive, but predictive: it anticipates emotional and social states, updating the individual's internal model of group interactions. It becomes crucial to examine, again, the effect of culture on cognitive processes. Emotional regulation varies depending on the culture of reference and, in this sense, may influence the prevalence and expression of stereotypes, especially when modulated by specific emotional responses.

The role of motivation in stereotypes

Implicit stereotypes allow the categorisation of the social world around us into groups oriented by individual attitudes and beliefs (Allidina & Cunningham, 2023). Categorisation is a process influenced by different needs, such as the needs for sharing and belonging, which can direct attention to specific dimensions and categories. Motivation is the cognitive process that seeks to respond to individual needs and understanding its role in the early stages of social categorisation allows us to highlight how and when stereotypes begin to form. Motivational processes can shift the attention of individuals to specific dimensions of social categories, such as ethnicity, gender, age. For example, when individuals are motivated by the need to obtain benefits, they try to avoid those social groups perceived as threats to their resources or interests (Allidina *et al.*, 2024; Allidina & Cunningham, 2023). Motivation varies among individuals and influences how information is processed. The application of cognitive shortcuts as stereotypes is, therefore, an active process, also influenced by motivational factors, e.g. through the selection of stereotypes that support one's initial attitudes and the inhibition of stereotypes that interfere with that impression. Since motivation can influence the cognitive processing of individuals, leading to biases and distortions in their perceptions of social categories (Kunda, 1990), it is crucial to emphasise the ways in which this influence occurs at the attentional level.

Motivation also plays a central role in responding to the needs of belonging, especially when put in relation to Turner *et al.*' (1979) social identity theory. Belonging to a group leads individuals to experience higher self-esteem and motivates them to maintain or improve the group's status and prestige. To achieve this, they will use outgroup and ingroup differentiation strategies, facilitating the creation and use of stereotypes. Consequently, motivation also influences how individuals interact with the ingroup and outgroup. Keeping one's group status high can lead to the enactment of behaviours that perpetuate intergroup differences and inequalities (Corenblum & Stephan, 2001; Goodwin *et al.*, 1998).

Although motivation plays a significant role in stereotype formation, the analysis presented so far shows that it is also affected by other variables, such as cultural and social norms and cognitive biases; therefore, motivation as a cognitive process underlying stereotype formation and maintenance cannot be separated from an understanding of the influence of culture. Considering the predictive brain framework, motivation operates as an anticipatory mechanism, that allocates precision to certain predictions over others (Clark, 2018). Motivational states signal which outcomes are most relevant to the organism, enhancing the precision weighting of predictions that reduce uncertainty about goal-relevant stimuli. This could mean that motivation biases the inferential process toward expectations, that align with social outcomes (such as maintaining in-group coherence or achieving social approval). Therefore, motivational drives can sustain the stereotypical assumptions, if they serve to minimise social prediction errors, even when conscious endorsement is missing. On the contrary, when motivational goals shift, they can recalibrate predictive hierarchies, leading to a gradual attenuation of pre-existing prejudices and promoting more flexible social inference.

Influence of culture

The pervasive impact of culture on stereotypes is a crucial aspect that has been consistently overshadowed by the prevailing focus on cognitive biases within individuals. Stereotypes, however, are shaped by the social environments in which individuals live, and conversely, shape the cultural contexts in which they are embedded. Stereotypes, in fact, are more malleable than early theories suggested (Chaiken & Trope, 1999; Devine, 1989; Fazio *et al.*, 1995) and respond to the current inputs, including thoughts and social context, of the perceiver, not limited to simple, well-learned associations. Recent empirical work further supports this view by showing that stereotypes can change over time in response to shifts in social norms and institutional practices (Nelson & Olson, 2024; Roberts & Rizzo, 2021). These findings reinforce the understanding of stereotypes as evolving cultural constructs rather than static cognitive representations. Following this perspective, stereotypes are forms of cultural knowledge, beliefs and shared assumptions - which individuals acquire through experiences in a specific cultural context. In his pioneer studies on stereotypes and prejudices, Allport (1985) already observed that these "manifestly come from somewhere". The same concept was also explained by Lippmann (1957), who argued that it is culture, not the individual, that creates stereotypes, highlighting their cultural origins (Hinton, 2017).

It is interesting to consider which stereotypical associations are, at the cultural level, most frequently explored and, more broadly, most remembered. Associations made about an artist, a professor, an engineer may be seen as prejudices, but there is little psychological research that challenges them. This is mainly because research on stereotypes focuses on their socio-cultural and political implications. Therefore, we find a lot of research on stereotypes and specific topics such as gender, ethnicity, age, sexuality and disability. Implicit evaluations, which are manifested through behaviour in everyday life, reflect the deep-rooted cultural structures. For instance, in Western culture, there are expectations of belonging to social classes based on ethnicity and gender (Bjornsdottir *et al.*, 2024). Furthermore, the image of migrant and refugee populations is often associated with low-skilled people from non-Western countries (Olier & Spadavecchia, 2022), largely because skilled migrants are underrepresented in Western media. Stereotypical representations of ethnicity and gender arise from narratives that have been perpetuated, varying and evolving over time, by social systems of inequality; fortunately, culture is something that can actively change through the construction of the social world and the media environment (Burr, 2015) and in this sense, conscious beliefs and values can contradict implicit biases. The "Predictive Brain" model helps explain why stereotypes persist even when consciously rejected. To predict social interactions, the brain relies on the most accessible information, which is often stereotypes; therefore, even if individuals have egalitarian beliefs, prevailing stereotypes can affect their implicit judgments (Fiske & Taylor, 2021). Stereotypes are also affected by culture in their communication. Previous research has shown that information consistent with stereotypes tends to be emphasized and transmitted, while information inconsistent with stereotypes, despite capturing attention, is less likely to be transmitted. This process causes stories to become more stereotypical and culturally consistent with each repetition, reinforcing the stereotype within the social group (Stangor & Crandall, 2013; Yeung & Kashima, 2010).

As already anticipated, however, the process of influence between stereotypes and culture is reciprocal. When the stereotype is established within a culture, certain behaviours and attitudes can be perpetuated among the members of different groups. An interesting example comes from the analysis of Qu (2023) who highlighted how the stereotype of the rebellious and irresponsible adolescent present in Western cultures can influence the expectations and behaviour of adults towards adolescents, which influences the development and behaviour of adolescents, reinforcing the pre-existing stereotype. Again, taking up the work of Olier and Spadavecchia (2022), the culture that sees Western whites moving abroad as "global citizens", qualified people or professionals, as "expats" while "non-white" people, regardless of their qualifications or professions, are identified as "immigrants", leading to different legal and social treatment (Kunz, 2016; Leinonen, 2012). Not only the historical roots of discrimination, then, but also the media play a fundamental role in modifying and reflecting cultural norms and stereotypes. From the differences between "immigrants" and "expats", but also in the cultural influences given by dressing or hair that are "stylish" if worn by white people but "unprofessional" by BIPOC (Black, Indigenous and People of Colour) (Allidina *et al.*, 2024).

Implications for reducing inequalities

The integration of cognitive and cultural perspectives on implicit stereotypes offers a framework for identifying effective strategies to reduce inequalities across multiple domains. If stereotypes are understood as predictive processes shaped by culturally acquired priors, interventions must operate at both the individual and structural levels. Specifically, reducing inequalities requires not only modifying individual cognitive mechanisms, such as attention, motivation, and emotion regulation, but also transforming the cultural environments that continuously reinforce stereotypical associations. In educational contexts, stereotypes influence expectations, evaluation processes, and student outcomes through predictive mechanisms that guide perception and interpretation. Teachers' expectations, often shaped by culturally embedded stereotypes, can reinforce inequalities by affecting students' performance and self-perception. This mechanism is consistent with evidence on stereotype threat, which shows how culturally embedded expectations can negatively affect the performance of individuals from stereotyped groups (Steele, 1997). From this perspective, interventions should focus

on systematically updating predictive models through sustained exposure to counter-stereotypical information and inclusive representations. Additionally, promoting metacognitive skills in both educators and students may help individuals recognize how automatic expectations influence judgments, thereby increasing awareness and reducing the uncritical application of stereotypes. These approaches align with the need to modify both cognitive processes and the cultural narratives embedded in educational systems. Interventions designed to address these mechanisms, particularly those targeting students' beliefs and expectations, have been shown to produce scalable and lasting improvements in educational outcomes (Yeager & Walton, 2011). In occupational settings, implicit stereotypes can affect recruitment, evaluation, and decision-making processes, particularly under conditions of time pressure and cognitive load, where reliance on heuristics increases. Empirical evidence has consistently shown that such biases can influence hiring decisions, even when qualifications are identical, reflecting the impact of implicit associations on evaluative judgments (Bertrand & Mullainathan, 2004). Understanding stereotypes as products of predictive and motivational processes highlights the importance of reducing reliance on automatic judgments through structured decision-making procedures. Behavioural design approaches further suggest that modifying decision environments, for instance through anonymization or standardized evaluation criteria, can significantly reduce the influence of bias in organizational settings (Bohnet, 2018). Interventions such as standardized evaluation criteria, anonymized application processes, and accountability mechanisms can mitigate the influence of implicit biases. Furthermore, addressing the motivational and emotional dimensions of decision-making, for instance through training in emotion regulation and bias awareness, may reduce the likelihood that stereotypes are selectively activated to serve individual or group interests. At the societal level, stereotypes are maintained and transmitted through cultural narratives, media representations, and social communication processes. From a "culture in mind" perspective, interventions must therefore target the broader socio-cultural environment that shapes and reinforces shared knowledge structures. Increasing the visibility of diverse and counter-stereotypical representations in media and public discourse can contribute to reshaping the statistical regularities on which predictive processes rely. Exposure to counter-stereotypical exemplars has been shown to reduce implicit bias by reshaping the associative structures underlying social perception (Dasgupta, 2013). Over time, this may lead to changes in implicit expectations by altering the cultural priors that guide social perception. Importantly, such changes require coordinated efforts across institutions, media systems, and policy frameworks to ensure that alternative representations are not episodic but become part of stable cultural knowledge. At the same time, large-scale social interventions, including media and community-based programs, have demonstrated potential to shift social norms and reduce prejudice at a broader societal level (Paluck & Green, 2009). Overall, these considerations suggest that reducing inequalities requires interventions that operate simultaneously at multiple levels, targeting cognitive mechanisms, motivational processes, and cultural structures. Isolated strategies focusing exclusively on individual attitudes are unlikely to produce lasting change, as they do not address the broader systems in which stereotypes are embedded (Forscher *et al.*, 2019). By linking predictive cognitive processes with cultural dynamics, the present framework highlights the need for integrated and sustained approaches capable of reshaping both individual cognition and the social environment in which it develops.

Conclusion and future perspectives

The implications outlined above further demonstrate how an integrated cognitive and cultural perspective can inform more effective strategies to address persistent inequalities across domains. Considering the variables examined so far and pointing out that they are only a part of human functioning and the complex relationships that can contribute to the creation and maintenance of stereotypes, it becomes clear that there is a need to integrate the theoretical approaches most used to study and investigate stereotypes from a perspective that is beyond the consideration of culture or the underlying cognitive processes alone.

Thinking of stereotypes solely as bias risks erasing the entire cultural aspect that differentiates stereotypes between different groups. At the same time, however, considering only the cultural approach risks leading to an underestimation of human cognitive functioning, which makes implicit stereotypes difficult to modify and eradicate. There is no doubt that cognitive processes play an important role in the persistence of stereotypes: it is this functioning that unites human beings and makes biases universal.

Integrating cognitive and cultural approaches may prove to be the best way to understand how their connection influences the establishment of stereotypes. From this integrated perspective, important implications emerge for reducing inequalities and promoting equity across different domains. If implicit stereotypes are understood as predictive and culturally embedded processes, interventions should aim not only at correcting individual biases but at systematically reshaping the informational and cultural environments that sustain them. In educational contexts, this implies fostering sustained exposure to counter-stereotypical representations and promoting metacognitive awareness of how expectations guide perception and learning processes. In occupational settings, it suggests the need for structured decision-making procedures that reduce reliance on heuristic processing, alongside interventions that address motivational and emotional drivers of biased judgments. At the societal level, it highlights the importance of transforming cultural narratives and media representations that reinforce stereotypical associations, recognising their role in continuously updating the

"priors" on which social perception is based. Crucially, this perspective underscores that effective change requires coordinated action across cognitive, institutional, and cultural levels. Isolated interventions targeting only individual attitudes are unlikely to produce long-term effects unless they are embedded within broader structural and cultural transformations. By explicitly linking cognitive mechanisms with cultural dynamics, this framework provides a more comprehensive basis for designing interventions aimed at reducing systemic inequalities. The use of interdisciplinary perspectives that combine both cognitive science and social psychology makes it possible to explore the complexity in stereotype formation and change. Especially in a rapidly changing society such as the one in which we currently live, which sees the use of artificial intelligence and machine learning systems as tools that the general population increasingly turns to for advice or to solve problems, analysing, as numerous studies are already doing, the ways in which cognitive and cultural biases influence programming languages can be a first way of understanding not only the cultural stereotypes present in our culture but also ways of tracking and understanding stereotype dynamics in different cultures and social groups (Ahn *et al.*, 2022; Craiut & Iancu, 2022). Integrating the study of psychology with computer science could allow the analysis of different perspectives, the creation and collection of new data that can capture a more accurate picture of the reality, including through longitudinal studies that analyse its evolution over the years.

A further important focus concerns the analysis of the cultural groups these studies address. Research to date has focused more on race, gender and sexual orientation, trying as much as possible to take an intersectional approach. However, the increasing focus on forms of discrimination within the general population, and not only within the scientific community, opens the door to an increasing need for integration and requires ever greater complexity for an effective understanding of the social context in which we live. These changes call for the scientific community to be ready to question its own biases but above all to seek new insights and new perspectives even within what is already known, highlighting results that are not significant or that go in different directions from those expected, to open new insights into the underlying reasons.

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Ethical approval and consent were not required.

Citation diversity statement
Following the work from Zurn *et al.* (2020), to proactively consider choosing references that reflect the diversity of the field in thought, form of contribution, gender, race, ethnicity, and other factors, I used databases that store the probability of a first name being carried by a woman and the probability of a first and last name being carried by an author of colour. As per gender diversity, by this measure and excluding self-citations to the first and last authors of our current paper), this paper contains 24.07% woman (first)/woman (last), 11.11% man/woman, 14.81% woman/man, and 50.0% man/man. This method is limited in that a) names, pronouns, and social media profiles used to construct the databases may not, in every case, be indicative of gender identity and b) it cannot account for intersex, non-binary, or transgender people. As per ethnicity, by this measure (and excluding self-citations), this paper contains 5.15% author of colour (first)/author of colour (last), 13.28% white author/author of colour, 14.77% author of colour/white author, and 66.80% white author/white author. This method is limited in that a) names and Florida Voter Data to make the predictions may not be indicative of racial/ethnic identity, and b) it cannot account for Indigenous and mixed-race authors, or those who may face differential biases due to the ambiguous racialization or ethnicization of their names.

Data availability
The conceptualization and writing of the present essay did not involve the use of datasets.

Additional information
DeepL translate (https://www.deepl.com/en/translator) was used to check for English-grammar and for help in English translation. Even if this is not a Generative AI tool, this translator is LLM based. The author takes full responsibility for the content, interpretation, and final wording of the text.

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Open Peer Review

Current Peer Review Status: ? ✗ ✗ ✗

Version 3

Reviewer Report 14 August 2026

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✗ **Sabine Glock**
University of Wuppertal, Wuppertal, Germany

Thank you very much for giving me the opportunity to read and comment on this review article on stereotypes. I was not involved in the first round of reviews and also feel that the first review was a little bit brief in order to help the authors to improve their manuscript. Therefore, I do not comment on the authors' responses to the review but read the manuscript with a fresh eye.

In the introduction, I miss literature to support the authors' assumptions. This almost holds for each sentence, as the authors provide arguments from other authors in these sentences. The authors should also define automatic stereotypes, as well as implicit and explicit stereotypes. I am also sure that a general definition of stereotypes and how they are forming would help the reader to understand the construct. It should also be self-evident that the when citing the IAT the authors who first introduced this method should be cited. This emerges as a main point of criticism: the authors often do not cite the persons who made their claims and arguments for the first time.

What I am missing throughout the manuscript, is a clear aim and the scientific contribution this manuscript can make to the literature. I miss a systematic on how the different variables have been chosen and justified.

Why emotion regulation? Why motivation? Why heuristics and decision-making and did the authors choose the two models culture in mind and the predictive brain? Why cultural influences and how can stereotypes reduce inequality?

In sum, the manuscript and the review on stereotypes is a narrative review and not a systematic one.

A such, the review remains on a rather superficial level. In my opinion, the different sections of the manuscript are not really theoretically grounded and connected.

To strengthen the review and to improve this manuscript I would strongly suggest to base the review on a strong theoretical rationale on the two chosen models and to draw conclusions that

follow from the two models. Then I would suggest to systematically search stereotype literature for two models and to falsify the models on the basis of the literature. As it stands now, the manuscript does not make a significant contribution on the stereotypical literature, also because there is no systematic literature search to draw stringent conclusions.

Minor- Please ensure a careful proof reading.

Is the topic of the essay discussed accurately in the context of the current literature?
No

Is the work clearly and cogently presented?
No

Is the argument persuasive and supported by appropriate evidence?
No

Does the essay contribute to the cultural, historical, social understanding of the field?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: stereotypes, attitudes, social inequalities

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 13 August 2026

https://doi.org/10.21956/openreseurope.26043.r76293

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Prachi Solanki
Michigan State University, East Lansing, USA

This essay proposes combining Clark's "Predictive Brain" framework and Hinton's "Culture in Mind" perspective to better understand the cognitive roots of implicit stereotypes. The author indicates how 1) various areas like decision-making, emotion regulation, motivation, and cultural contexts impact implicit stereotyping and 2) implicit stereotypes manifest in society as prejudice and discrimination. The author also notes implications for reducing inequalities in educational, occupational, and societal settings through appropriate interventions based on their proposed theory.

COMMENTS

1. **Implicit stereotyping:** The author suggests throughout the paper that researchers must adopt a new perspective to study implicit associations and stereotyping. However, the author fails to break down for the reader what exactly an "implicit association" or "implicit stereotype" means and why adopting this new theory makes sense given existing empirical evidence. Importantly, how did "implicit" associations come to be studied in social psychology and how are these associations currently being defined and used? The concept came from cognitive psychologists studying memory and information processing. This contextual history is important but currently missing from the paper. The author must make clear for the reader how social psychologists have generally altered how they conceptualize, use, and measure "implicit associations" compared to the original cognitive psychology experiments. Please also provide a clear discussion about implicit associations as a construct; specifically about them being automatic, learned, and unconscious which of these is the author is trying to address? Which have been and can be supported by empirical evidence? Which of these does the IAT measure and how well does the IAT do so? Empirical evidence must be cited so the reader can form their own opinion regarding the robustness of current implicit association definitions, usages, measures, and implications.
2. **Insufficient anchoring in the existing theoretical literature on stereotypes.** I agree with the other reviewer on this point and suggest the author incorporate all the citations recommended by the reviewer (e.g., Devine (1989), Fiske & Neuberg (1990), Kunda & Thagard (1996), Brewer (1988), Fazio (1993), Fazio et al. (2003), Fiske et al., (2002)). In addition the author should also look into work by Cesario, J. (2006; 2010; 2013), Solanki & Cesario (2025) and Priniski, Solanki & Horne (2024). I agree with the other reviewer that there is a need to restructure the introduction/theoretical background to present a more complete picture of existing models and theoretical perspectives before providing their own theory.
3. **Lack of empirical grounding for the two integrative frameworks.** Again, I agree with the other reviewer that the main sections of the paper (Predictive Brain and Culture in Mind) do not cite any empirical work to explicitly lend support to the author's theory. Please use existing empirical evidence/data to strengthen all theoretical claims in the current paper.

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Is the topic of the essay discussed accurately in the context of the current literature?
Partly

Is the work clearly and cogently presented?
Partly

Is the argument persuasive and supported by appropriate evidence?
Partly

Does the essay contribute to the cultural, historical, social understanding of the field?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Judgement and decision-making, stereotypes, impression formation, bayesian updating

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 23 July 2026

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Aïna Chalabaev
Université Grenoble Alpes, Grenoble, France

This essay proposes an integrative theoretical account of implicit stereotype formation and change, combining Clark's "Predictive Brain" framework and Hinton's "Culture in Mind" perspective. Building on this dual lens, the authors examine how decision-making, emotion regulation, motivation, and cultural context contribute to both the persistence and the malleability of automatic stereotypes. The paper further discusses implications for reducing inequalities in educational, occupational, and societal settings. While the manuscript presents several strengths, it could be improved by taking into account the following remarks.

MAJOR COMMENTS

1. **Insufficient anchoring in the existing theoretical literature on stereotypes.** The manuscript does not build a complete state-of-the-art before introducing its own integrative contribution. Several foundational and well-established models are either underused or absent:

- Devine's (1989) dual-component proposition (automatic vs. controlled processes) is one of the pioneering accounts of the implicit/explicit distinction, yet it is only mentioned briefly and quite late in the text, rather than being presented as a founding framework early on.
- Fiske and Neuberg's (1990) continuum model of impression formation is cited in the introduction but never actually presented or discussed.
- Other established models are missing entirely, notably Kunda and Thagard's (1996) parallel-constraint-satisfaction theory of impression formation and Brewer's (1988) dual-process model of person perception.
- Depending on space, the authors may also want to consider more recent frameworks that are directly relevant but currently absent: the et le, the Quad model (Conrey et al., 2005), Fazio's MODE model, and the Stereotype Content Model (Fiske et al., 2002).

Recommendation: Restructure the introduction/theoretical background so that the existing models are presented in an organized, cumulative narrative first, and only then position the "Predictive Brain" / "Culture in Mind" integration as a novel contribution relative to that state of the art.

2. **Lack of empirical grounding for the two integrative frameworks.** Both the "Predictive Brain" section and the "Culture in Mind" section rely almost exclusively on Clark's and Hinton's own theoretical writings, without citing empirical studies on stereotypes that would support (or test) these accounts specifically.
Recommendation: Add empirical references demonstrating predictive processing to strengthen the case that these are not purely speculative reinterpretations.

MINOR COMMENT

1. **IAT is under-referenced and its explanatory potential is underused.** The Implicit Association Test is introduced later in the text without a citation (the original reference, Greenwald, McGhee & Schwartz, 1998, is missing). More substantively, the IAT could also be used earlier, in the first paragraph, as a concrete illustration that automatic responses are not fixed and can be modified by motivated individuals - which would reinforce the paper's opening argument rather than only appearing later as a measurement tool.

SUGGESTION

1. **Density of the "Implications for reducing inequalities" section.** This section currently reads as a single, very dense block covering educational, occupational, and societal levels together. Splitting it into separate paragraphs per level would improve readability and let each set of recommendations stand out more clearly.

Is the topic of the essay discussed accurately in the context of the current literature?

Partly

Is the work clearly and cogently presented?

Partly

Is the argument persuasive and supported by appropriate evidence?

Partly

Does the essay contribute to the cultural, historical, social understanding of the field?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Stereotypes, motivation, health behaviors

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Version 2

Reviewer Report 29 January 2026

https://doi.org/10.21956/openreseurope.23489.r67778

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?

Fahriye Altinay
Near East University, Northern Cyprus, Turkey

Essay points out crucial aspects by underlying the stereotypes, cognitive processes and also cultural concerns. Although the essay covers different dimensions, there is no clear cut about the aim of the essay and importance of its contributions to the field. There is an intensified need to add update references. In addition to this, it is essential to discuss how to reduce inequalities and equity in educational, occupational and social contexts in detail based on cultural and cognitive understanding. Implication of these connections need to be written in detail.

Is the topic of the essay discussed accurately in the context of the current literature?
Partly

Is the work clearly and cogently presented?
Partly

Is the argument persuasive and supported by appropriate evidence?
Yes

Does the essay contribute to the cultural, historical, social understanding of the field?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: educational technology, educational management, disability, sustainable development goal

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 18 May 2026

Giulia Lausi

I sincerely thank the reviewer for their careful reading of our manuscript and for the constructive and insightful comments. The manuscript has been substantially revised to address all concerns raised. Below we detail how each point has been addressed.

1. Clarity of the aim and contribution
Response: I agree that the original version did not sufficiently articulate the aim and the contribution of the essay. The revised manuscript now explicitly states the aim in both the abstract and the introduction; defines the theoretical contribution to conceptualise implicit stereotypes as probabilistic and culturally embedded processes; clarifies how this framework advances current debates in the field. Hopefully, these additions improve the overall coherence and positioning of the manuscript.

2. Engagement with current literature
Response: I have expanded and updated the literature throughout the manuscript to better reflect recent developments in the field. Particularly, work on implicit bias as a context-dependent and dynamic process has been incorporated; the discussion on cultural dynamics and stereotype change is strengthened with recent empirical studies; the predictive processing framework is further supported with more recent theoretical developments.

3. Implications for reducing inequalities
Response: To address this, I have added a new dedicated section, where a detailed discussion of how cognitive and cultural mechanisms translate into inequalities has been provided; concrete strategies across educational, occupational, and societal domains has been outlined; cognitive processes have been explicitly linked to structural and cultural interventions.

4. Overall clarity and structure
Response: Several sections of the manuscript have been revised to improve clarity, coherence, and argumentative flow. I believe that these revisions substantially improve the manuscript and address all of the reviewer's concerns and I'm grateful for the valuable feedback.

Competing Interests: No competing interests were disclosed.