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Review Paper

Behavioral and Biological Bases of Herding and Conformity

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ABSTRACT

Humans are inherently complex creatures, and this issue became even more complicated when they decided to construct social relationships. Research into human behavior is an interdisciplinary and multifaceted endeavor studied by various disciplines, such as psychology, economics, sociology, anthropology, and neurosciences. Today, with the cooperation of researchers in different fields, it is possible to link the cellular dynamic of neurons to brain function and human behavior. Cognitive science and neurosciences, along with other disciplines, can enrich our knowledge about mechanisms of social influence, which may assist policymakers in influencing public behaviors toward creating a better society. This review aims to describe previous research on social influence's behavioral, cognitive, and neural basis and provide more understanding of human behavior in society. I review and evaluate the relevant literature from multiple databases of peer-reviewed journals, books, and conferences and hand-searching reference lists of relevant studies that consider conformity from psychological, economic, neurobiological, and neurochemical aspects. This paper has been divided into four parts. First, I start by defining and describing two kinds of social influences. The second section focuses on psychological and economic evidence of social influence. It will then explore the neurobiological and neurochemical approaches to studying social influence. Finally, the conclusion summarizes and highlights three points I believe social neuroscience as an interdisciplinary and vibrant field should consider for future developments.

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Highlights

- Conformity can be influenced by factors like sex, age, and culture.
- Rostral cingulate zone (RCZ), ventral striatum, nucleus accumbencs (NAc), and amygdala are the major parts of the brain that are involved in social influences.
- Serotonin and oxytocin promote conformity.

Plain Language Summary

Scholars from various fields, such as psychology, economics, anthropology, sociology and neuroscience, are collaborating to comprehend how our brains and behaviors influence one another. This paper reviews existing research on social influence—how people's thoughts and actions are shaped by others—and aims to shed light on the biolog-ical and psychological mechanisms behind it. The review covers several key areas: First, it defines the two main types of social influence. Next, it discusses psy-chological and economic evidence that shows how our choices can be influenced by those around us. It then looks at the brain's biology and chemistry to explore how these social influences manifest physically. finally, the study highlights important points for future research in this interdisciplinary field.

1. Introduction

Highly social animals[1], especially our close primate cousins and indeed humans, are fundamentally motivated to establish social relationships (Cialdini & Goldstein, 2004) to get the benefits of a variety of social interactions such as protection, coordination, collaboration, gaining information (Rocha et al., 2021).

Societal bonds are crucial to human welfare; all humans thrive off social connections. Psychologists have cited this issue as one of the essential factors in human survival and believe that people have a basic "need to belong" or socialize with others (Baumeister & Leary, 1995; Eisenberger, 2012).

Therefore, individuals strive to maintain their linkage to others so that society does not ostracize them (Wasylyshyn et al., 2018), as it is considered a powerful form of social punishment.

These connections may be disrupted, such as when an individual is excluded from a group. People react differently to this social experience, and those who experience a strong need to belong might particularly adapt their behavior to fit in with others.

Conformity and obedience are two types of social influence that are inherent components of most social behaviors so that people under the influence of others' opinions are encouraged to align their own beliefs, feelings, values, and behaviors with someone else (Levy, 2008; Wang & Busemeyer, 2021; Xie et al., 2016; Zheng et al., 2021).

"Conformity is as old as humanity." It is not limited to a specific time and place (Sunstein, 2020). Before proceeding, it is necessary to clarify the difference between conformity and obedience. The main difference between obedience and conformity is that obedience is an act of following orders coming from someone with a higher status and relies on social power without any question. In contrast, conformity is a trait that allows human beings to follow social norms and go along with people with equal status, and it relies on the need to be socially accepted.

Conformity can be seen in our daily decisions, such as where to live, how to spend money, or changing lifestyles, such as going to the gym or having a healthy diet (Nook & Zaki, 2015).

In fact, not all types of conformity are identical. Traditionally, two distinct influences that drive conformity behavior have been distinguished (Deutsch & Gerard, 1955). The first is informational conformity, which is taking advantage of the information acquired by others. This kind usually occurs when people lack knowledge

1. Aristotle, the legendary Greek philosopher, said, "Man is by nature a social animal, he must satisfy certain natural basic needs in order to survive."

and try to change their minds with someone else who has more accurate information because of the desire to be correct.

In this connection, self-confidence plays a significant role in informational conformity. People are prone to conform more because they are uncertain about the correctness of their beliefs and hold low self-confidence and self-doubt (Cross et al., 2017; Morgan et al., 2012; Zheng et al., 2021).

The second is normative conformity, which is often less conscious (Baddeley, 2018). It refers to fulfilling social norms to avoid sanction for deviating from norms (Carpenter, 2004) and to gain acceptance or maximize group cohesion (Mahmoodi et al., 2022). They copy others because they feel compelled by others around them. Also, they tend to look good in front of other people. Image-related concerns only occur if the individual's actions are observable to other people (Zafar, 2009).

Some studies have shown that self-esteem[2] can also influence social influence. People with low self-esteem may be more likely to be influenced by others (Kaplan, 1985; Stacy et al., 2016).

Tacit knowledge that we have gained from personal experience allows our brain to sometimes take cognitive shortcuts and follow rules of thumb in an uncertain situation; that is why people imitate. Gigerenzer and Goldstien (1996) described imitation as a kind of conformity that is "the fast and frugal heuristic in social situations."

Social influence: Psychological and economic evidence

Conformity behavior cannot be fully understood from a single perspective. This phenomenon has been widely studied by a plethora of previous researchers in different fields (Asch, 1955; Baumeister, 1982; Bond & Smith, 1996; Chein et al., 2019; Deutsch & Gerard, 1955; Duell et al., 2021; Goeree & Yariv, 2015; Janes & Olson, 2000; Klucharev et al., 2009; Muzafer Sherif, 1935; Xu et al., 2019) for several decades.

The overall summary of the research publication related to the social conformity topic is shown in Figure 1.

Psychology, behavioral economics, sociology, and biology attempt to tackle the topic of conformity from various angles and explain the different motivations for this phenomenon. For example, psychology studies stress the rewarding value of gaining social acceptance or "affiliation with others" (Cialdini & Goldstein, 2004). Meanwhile, in behavioral economics, attention is more on the effects of punishment for breaking or ignoring the norm (Klucharev et al., 2009). For instance, (Akerlof, 1980) assumed that the community sanctions factor may explain the tendency to conform, and deviations from social customs are punished by loss of social reputation.

The first serious discussion and analysis of such social phenomena emerged during the 1890s with crowds and mass psychologists like Gustave Le Bon and Gabriel Tarde. According to Tarde (1903), imitation was a collective hypnosis called "social somnambulism".

Modern economists have neglected psychological and sociological factors and solely focused on explaining conformity as the outcome of mathematical algorithm calculations like Bayesian updating in the Bayesian inference method (Baddeley, 2010).

The first studies in the literature on the impact of socio-psychological forces on economics, like sudden shifts in consumer behavior, were addressed by Veblen (1899) and Cox and Katona (1976).

Economic psychologist Cox and Katona (1976) conducted many studies using cognitive psychology to analyze how individuals learn from groups (Baddeley, 2010).

Also, Keynes, who famously spoke about "contagious animal spirits," draws our attention to sociological and psychological forces of herding behavior (bandwagon effect) that is often observed in stock markets, which affect investors in times of uncertainty (Baddeley, 2010; Chen & Chen, 2020) and crisis. It is necessary to clarify that herding behavior is a group phenomenon; in other words, many people emulate one person, and many emulate others with unconscious motivation (Baddeley, 2018).

Personality factors, such as age, gender, and cultural differences can influence conformity. According to a meta-analysis by Bond and Smith (1996), females are more likely to conform than males. This difference in conformity between sexes has been attributed to social explanation, which means women care more about others' desires. Still, the role of evolution in explaining this difference also should not be neglected (Griskevicius et al., 2006).

2. The terms self-esteem and self-confidence are often used interchangeably. Self-confidence is about how a person has faith in their own capabilities and abilities, whereas self-esteem refers to how a person appraises overall their own value.

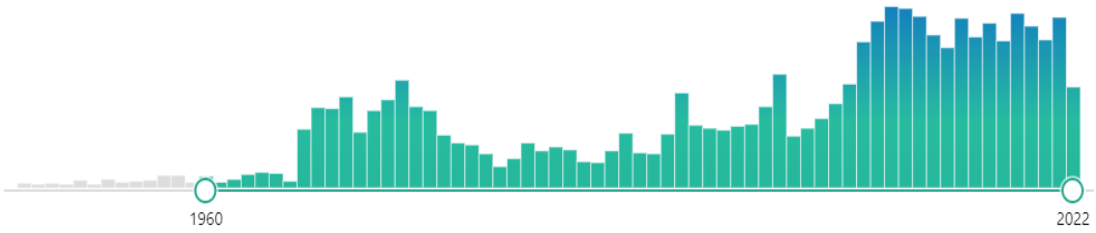

Figure 1. Social conformity research trends publication per year

Moreover, the literature reveals that an individual's age also matters and significantly affects the rate of social conformity. Studies show that individuals in early and late adulthood are more easily influenced than individuals in middle age (Visser & Krosnick, 1998; Wijenayake et al., 2021).

In addition to personality factors, evidence suggests that cultural traits also significantly influence an individual's motivation to conform.

Bond and Smith (1996) reported a strong empirical relationship between collectivistic and individualistic cultures and conformity using Asch's line judgment task. People in collectivistic countries like the Middle East are more susceptible to conform than in individualistic countries. The questions that arise here are as follows: What are the implications of conformity and herding behavior for our everyday lives? Should we conform or act as a contrarian?

The answer to the above question lies in another question: Are crowds better at always making decisions?

Surowiecki (2004), in his book "The Wisdom of Crowds," claims that collective decisions are more likely accurate than individual ones if we put together a large enough diverse group of people. In the introduction, he tells the story of the great British scientist Sir Francis Galton (Charles Darwin's cousin), who was at a country fair in West England in 1906, where there was a wagering competition to guess the weight of an ox.

Seven hundred eighty-seven villagers' guesses were 1197 pounds, whereas the ox's actual weight was 1198. He expected the outcome to be unreliable. Instead, surprisingly, he found a small crowd error that contradicted his idea about the inferiority of the crowd.

However, under the right circumstances, collective decisions are more likely correct than individual decisions. The first requirement is the independence of source information, meaning that people's decisions should be independent of one another. Second, the diversity of people's minds in a group plays a significant role in making more accurate predictions.

To answer the above questions, we can say that herding behavior and conformity are not inherently positive or negative. Agreement with others may lead to more positive and less negative outcomes (Fehr & Fischbacher, 2004); therefore, their goodness depends on the nature of the issue and the various situations.

If sameness leads to an adverse effect on self-identity or encourages dependencies, obviously, in that case, it is harmful to society. Still, it may be seen as a positive if it provides access to new information and learning from an expert.

Social influence: Neurobiological evidence

While a considerable amount of literature in psychology and economics has been published on social influence, its neurobiological basis is poorly understood and has received relatively little attention; nevertheless, the field of social neuroscience is rapidly evolving.

The neuroscientific approach extends our knowledge about the mechanism of social conformity and offers excellent information in extending and validating competing psychological theories of conformity. Neuroscience research, especially neuroimaging, may also help predict who is more likely to change their behavior and conform (Stallen & Sanfey, 2015; Wu et al., 2016).

Social neuroscience adds noninvasive neuroimaging techniques to study the neural underpinnings of social influence. In the past decade, neuroimaging methods such as functional magnetic resonance imaging (fMRI), which measure changes in blood oxygenation level-dependent, and electroencephalogram have dramatically

provided jaw-dropping insights into the brain's black box.

Berns et al. (2005) extended the Asch perceptual experiment by using fMRI and a mental rotation task to investigate the neural mechanism of conforming behavior in which confederate gave erroneous responses regarding the degree of rotation of a figure. The authors pointed out that conformity was associated with visual cortical and parietal activation. Due to the absence of activity in the frontal lobes, authors claimed that change in participants' initial judgments could be attributed to low-level perception, which does not necessarily require attentional processes compared to agreeing with others at an executive level.

Previous neuroimaging studies have shown that the amygdala, located in the medial temporal lobe, may also play a role in social decision-making and learning. An fMRI study (Baddeley et al., 2012) reports that the amygdala activates the herding task. Neuroimaging techniques also allow researchers to distinguish the type of conformity at two different levels of internalization. At the public level, people change their behavior just to be liked and avoid rejection, while the group's beliefs are not internalized privately in an individual's belief system. In other words, they conform without changing real behavior (Stallen & Sanfey, 2015). When a person publicly and privately conforms with others, this is the deepest level of conformity, and this alignment is permanent. Figure 2 refers to the term-based meta-analyses conducted by Neurosynth, which analyzed 84 studies utilizing the term "imitation."

Several researchers have suggested that conformity and reinforcement learning have similar neural mechanisms and responses to conflict with social opinions. A seminal study by Klucharev et al. (2009) reports that deviation from group norms leads to activation in the rostral cingulate zone and ventral striatum, which are parts of the posterior medial frontal cortex (pMFC) and subcortical brain region, respectively. By using transcranial magnetic stimulation, which is a noninvasive technique

Klucharev et al. (2011) showed that the pMFC region can mediate the reinforcement learning mechanism and play a causal role in social influence. Correspondingly, other fMRI studies (e.g. Burke et al., 2010; Campbell-Meiklejohn et al., 2010) have replicated a similar experimental paradigm to capture cognitive components of conformity. Their findings consistently supported the previous original findings. Furthermore, there is a large body of literature that demonstrates the link between motor mimicry[3] (imitation) and observational learning with mirror neurons (Catmur et al., 2009; Raafat et al., 2009; Rizzolatti & Craighero, 2004).

Mirror neurons are a class of neurons first observed by chance in the macaque monkey premotor cortex at the Università Degli Studi di Parma, Italy, in the 1990s. Mirror neurons are a group of neurons that fire without conscious control when an animal or individual performs a particular action (motor system), and when the individual watches (sensory system), another agent carries out a similar action. Researchers discovered mirror neurons are essential for imitation behavior and observational learning (Cross et al., 2009).

The following section will argue neurochemical contributions to a better understanding social influence.

Social influence: Neurochemical evidence

From the neurobiology perspective, a bidirectional relationship exists between hormones, neurotransmitters, and behavior. Hormonal and neurotransmitter mechanisms regulate the behavior of individuals, such as anger, stress, and conformity. Consequently, hormones and neurotransmitters can modulate individuals' behavior (Duell et al., 2021), and sometimes behavior can influence hormone concentrations. So far, however, there has been little discussion about possible neurobiological mechanisms underlying conformity.

A hormone is different from a neurotransmitter in many respects. The term hormone (e.g. oxytocin, cortisol) often refers to any substance, such as proteins, lipids, or cholesterol-based molecules, produced by an endocrine gland. They are released and transmitted into the bloodstream, whereas neurotransmitters (e.g. dopamine, serotonin, epinephrine) are proteins or amino acids released into the synaptic gap and diffuse across the synaptic cleft.

Neurotransmitters typically produce speedy physiological responses within milliseconds, while hormones take a few minutes to a few days.

Both are different types of chemical messenger molecules that regulate human and animal behavior.

3.In The Theory of Moral Sentiments, Adam Smith (1759) writes: "Though our brother is upon the rack . . . by the imagination we place ourselves in his situation, we conceive ourselves enduring all the same torments, we enter as it were into his body, and become in some measure the same person with him, and thence form some idea of his sensations, and even feel something which, though weaker in degree, is not altogether unlike them.". In other words, people can imagine and feel themselves in another person's situation, technically they present "motor mimicry."

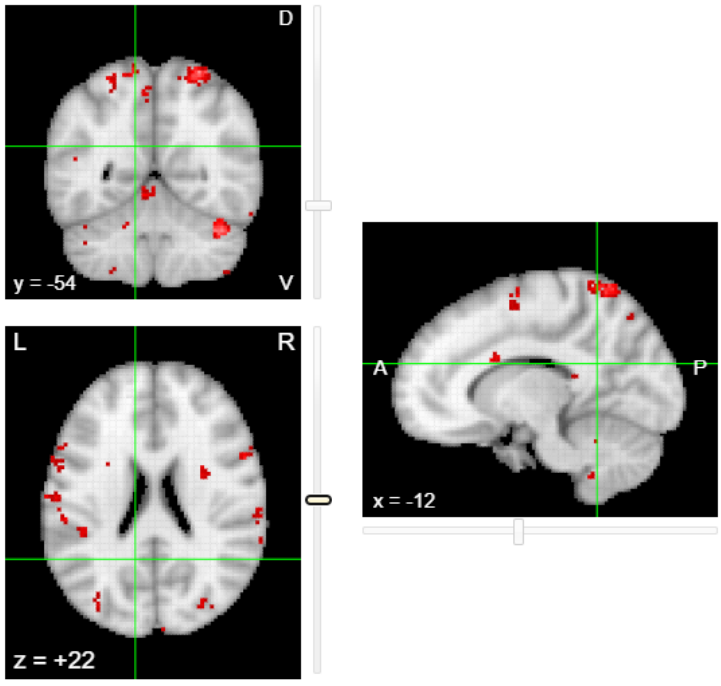

Figure 2. Neurosynth term-based meta-analyses of 84 studies used the word" imitation"

Notes: The likelihood of each coordinate and functional activation is related to studies that examine imitation (Neurosynth, 2022).

To better understand the role of hormones and their effects on conformity, Duell et al. (2021) investigated the neural correlates of conformity with two major classes of steroid hormones: Testosterone and cortisol. Adolescent participants underwent fMRI scanning while they were asked to donate their time to different types of charities. They saw the peer confederate decision behavior for probable revision in post versus pre-peer observation. After observing highly prosocial behavior, the authors concluded that high testosterone and low cortisol lead to prosocial behavior but remained unchanged for peers with low-level prosocial behavior. Their results were in agreement with prior studies (Báez-Mendoza & Schultz, 2013; Do et al., 2019; Hoorn et al., 2016; Spaans et al., 2019) on social cognition, which indicated observing high prosocial behavior enhances greater activation in the pSTS/TPJ, insula, orbitofrontal cortex, and caudate regions.

Serotonin (5-HT) is an ancient phylogenetics molecule (Nardi et al., 2017) that is highly responsive to social influences (Hogenelst, 2016).

This neurotransmitter plays a crucial role in social choices (Rogers, 2010) and affects observational learning through social interactions.

Simonsen et al. (2014) examined the role of serotonin in the judgment's alteration of trustworthiness in a facial rating task. Half of the subjects, all females, received a single dose of the selective serotonin reuptake inhibitor citalopram, which increases serotonin levels in the brain; the rest (control subjects) took a placebo. After each rating, immediate feedback was shown on how a third party rated the same face. The authors concluded that compared with placebo-treated subjects, those receiving citalopram conformed more to the judgments of others.

In another study, Campbell-Meiklejohn et al. (2012) examined the role of catecholamines, a neurohormone that belongs to the monoamine neurotransmitter, on social influence. The conformity task was similar to that described earlier (Klucharev et al., 2009; Simonsen et al., 2013). In a double-blinded placebo-controlled procedure and before the task, the experimental group received a single oral dose of methylphenidate (i.e. Ritalin), which increased the level of catecholamine, while the control group received a placebo. Researchers found that subjects who received methylphenidate were more inclined to conform than those who received a placebo.

A possible explanation for this might be that methylphenidate can enhance reward saliency by increasing

extracellular dopamine concentrations in the striatum (van Dyck et al., 2021), with indirect consequences for modulating social conformity.

Oxytocin is another important natural hormone that can modulate human behaviors and social interactions, such as trust and empathy (Shamay-Tsoory & Abu-Akel, 2016). It is a neuropeptide made in the hypothalamus, a regulatory center in the brain.

Stallen et al. (2012) aimed to examine the role of oxytocin in the opinion of the in and out-group members. Hypotheses were tested using a double-blind, placebo-controlled design experiment to rate a series of visual stimuli and symbols on attractiveness when in-group and out-group members express preferences. Before the task, nasal oxytocin spray was self-administered in the experimenter's presence. The dose was three puffs per nostril. The authors demonstrated that oxytocin promotes conformity to the opinions of the in-group in contrast to out-group members.

Conclusion

In summary, I have argued how and why individuals are susceptible to social influence in this review. Furthermore, why our everyday actions often can be affected by the choices or opinions of others.

Most experiments testing the social influence on conformity have used mental rotation tasks or rating tasks like facial expressions. Social influence and conformity have not been extensively investigated using behavioral game experiments in neuroscience domains, and very few studies have been conducted.

Moreover, in future research, it is essential to distinguish the neural mechanism of conformity and its contagion in prosocial and antisocial activities.

Our brain is a complex system and interconnected network. Future research must examine how different brain parts structurally and functionally communicate in conformity tasks. It can allow researchers to identify causal relationships in brain networks when the opinion of others guides decisions.

Ethical Considerations

Compliance with ethical guidelines

This article is a review with no human or animal sample.

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Conflict of interest

The author declared no conflict of interest.

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