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Title: Behavioral and Biological Bases of Herding and Conformity

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Highlights:

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

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Abstract:

Human beings are inherently complex creatures, and this issue became even more complicated when they decided to construct relationships in society. Research into human behavior is very much an interdisciplinary and multifaceted endeavor and is studied by a broad range of disciplines such as psychology, economics, sociology, anthropology also neurosciences. Today, with the cooperation of researchers in different fields, it is possible to link the cellular dynamic of neurons to brain function and relate it to human behavior.

Cognitive science and neurosciences, alongside other disciplines, can be used to enhance 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 the behavioral, cognitive, and neural basis of social influence 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 as well as hand-searching reference lists of relevant studies considering conformity from psychological, economic, neurobiological, and neurochemical aspects. This paper has been divided into four parts. First, I start with the definition and description of two kinds of social influences. The second section focuses on psychological and economic evidence of social influence. It will then go on to the neurobiological and neurochemical approaches to studying social influence. Finally, the conclusion gives a brief summary and highlights three points that I believe social neuroscience as an interdisciplinary and vibrant field should take into account for future developments.

Keywords: *Conformity, Herding, Neurobiology, Hormone, Neurotransmitter, Mirror neurons*

Introduction

Highly social animals¹, especially our close primate cousins and indeed humans, are fundamentally motivated to establish social relationships with others (Cialdini & Goldstein, 2004) to get the benefits of a variety of social interactions such as protection, coordination, collaboration as well as access to information (Rocha, Ryckebusch, Schoors, & Smith, 2021).

Societal bonds are crucial to human welfare; all humans thrive off social connections. This is an issue that psychologists have cited 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 keep their linkage to others so as not to be ostracized by society (Wasylyshyn et al., 2018) because 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 will be 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, whereas conformity is a trait that allows human beings to follow social norms and go along with people with equal status and relies on the need to be socially accepted.

Conformity can be seen in many of 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 that was distinguished by

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.”

(Deutsch & Gerard, 1955). The first is informational conformity, which is taking advantage of the information acquired by others. This usually occurs when a person lacks knowledge and tries to change his/her mind 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, Brown, Morgan & Laland, 2017; Morgan, Rendell, Ehn, Hoppitt & Laland, 2012; Zheng, Hu, Shen, & Wang, 2021).

The second is normative conformity which is often less conscious (Baddeley, 2018). It refers to fulfilling social norms to avoid being sanctioned for deviating from norms (Carpenter, 2004) as well as to gain acceptance or maximize group cohesion (Mahmoodi, Nili, Bang, Mehring, & Bahrami, 2022). They copy others because of feeling compulsion from others around also, they tend simply to look good in front of other people. Image-related concerns only if the individual's actions are observable to other people (Zafar, 2009).

Some studies have shown that self-esteem² can also play a role in social influence. People with low self-esteem may be more likely to others' influence

(Kaplan, 1985; Stacy et al., 2016).

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

Social influence: Psychological and economic evidence

Conformity behavior cannot be fully understood from a single perspective alone. This phenomenon has been widely studied by a plethora of previous researchers in different fields (Asch, 1955; Baumeister, 1982; Bond & Smith, 1996; Chein, Jansen, Korbee, & Bruijn, 2019; Deutsch & Gerard, 1955; Duell, Hoen, McCormick, Prinstein & Telzar, 2021; Goeree & Yariv, 2015; Janes & Olson, 2000; Klucharev, Hytonen, Rijpkema, Smidts, & Fernandez, 2009; Muzaffer Sherif, 1935; Xu, Becker, Kendrick, 2019) for several decades.

The overall summary of the research publication related to the social conformity topic is shown in figure

1.

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.

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). Whereas 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 tendency to conform may be explained by the community sanctions factor, 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, imitation was referred to as a form of collective hypnosis called “social somnambulism” (Rook, 2006).

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 Katona (1975).

Economic psychologist Katona (1975) carried out a large number of studies by applying 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 here to clarify that herding behavior is a group phenomenon; in other words, many people emulate one person, and many people emulate many people with unconscious motivation (Baddeley, 2018).

Conformity can be influenced by personality factors such as age, gender, and cultural differences. According to a meta-analysis done by Bond and Smith (1996) on average, females more likely to conform than males. This sex difference

in conformity has been attributed to social explanation, which means women care more about others' desires, but the role of evolution in explaining this difference also should not be neglected (Griskevicius, Goldstein, Mortensen, Cialdini, & Kenrick, 2006).

Moreover, literature noted that an individual's age also matters, and significantly affects the rate of social conformity. Studies showed that Individuals in early and late adulthood are more easily influenced than individuals who are in middle age (Visser & Krosnick, 1998; Wijenayake, Hu, Kostakos & Goncalves, 2021).

In addition to personality factors, there is evidence to suggest that cultural traits also play a significant role in influencing an individual's motivation to conform.

Bond and Smith (1996) by using Asch's line judgement task reported that there is a strong empirical relationship between collectivistic and individualistic cultures with conformity. People in collectivistic countries like the Middle East are more likely susceptible to conform than in individualistic countries. The question arises here, what do conformity and herding behavior implications 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 making decisions all the time?

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 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 1,197 pounds, whereas the ox's actual weight was 1,198. 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 independency of source information, meaning people's decisions should be independent of one another. Second is the diversity of people's minds in a group, which plays a big role in more accurate predictions.

In answer to the above questions, then 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 but it may be seen 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 received comparatively little attention, but (nevertheless) the field of social neuroscience is rapidly evolving.

The neuroscientific approach extends our knowledge about the mechanism of social conformity, as well as offers great information in extending and validating competing psychological theories of conformity. Neuroscience research, especially neuroimaging, may also be helpful to predict who is more likely to change the behavior and conform (Stallen & Sanfey, 2015; Wu, Luo, Fen, 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 (BOLD), and electroencephalogram (EEG) have dramatically provided us with jaw-dropping insights into the black box of the brain.

(Berns et al., 2005) extended Asch perceptual experiment by using functional magnetic resonance (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 point out that conformity is associated with activation in the visual cortical and parietal regions. 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 by contrast to agreeing with others at an executive level.

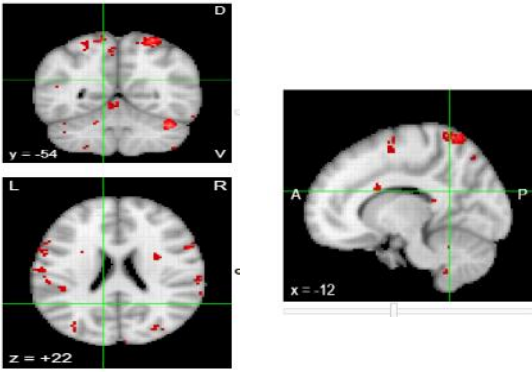


Figure 2 NeuroSynth term-based meta-analyses of 84 studies that used the word "imitation". The likelihood of each coordinate and functional activation is related to studies that examine imitation (from <https://neurosynth.org/> accessed on 26 August 2022).

Previous neuroimaging studies have shown that the amygdala, which is located in the medial temporal lobe, may also play a role in social decision-making and social learning. In the fMRI study, (Baddeley, Burke, Schultz & Tobler, 2012) reported that the amygdala displayed activation in the herding task. Neuroimaging techniques also allow researchers to distinguish the type of conformity at two different levels in terms of internalization. At the public level, a person changes his/her behavior just to be liked and avoid rejection, while the group's beliefs are not internalized privately in an individual's own 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 would be permanent.

A number of researchers have suggested that conformity and reinforcement learning have similar neural mechanisms and response to conflict with social opinions. A seminal study by (Klucharev et al., 2009) reported that deviation from group norms led to activation in the rostral cingulate zone (RCZ) and ventral striatum, which are parts of the posterior medial frontal cortex (pmFC) and subcortical brain region respectively. By using transcranial magnetic stimulation (TMS), which is a non-invasive technique

(Klucharev et al., 2011) showed that the pmFC region can mediate the reinforcement learning mechanism and plays a causal role in social influence. Correspondingly, other fMRI studies (e.g., Burke, Tobler, Baddeley, & Schultz, 2010; Campbell-Meiklejohn, Bach, Roepstorff, Dolan & Frith, 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 mimicry³ (imitation), and observational learning with mirror neurons (Catmur, Walsh & Heyes, 2009; Raafat, Chater & Frith, 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 that 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 of social influence.

Social influence: Neurochemical evidence

From the perspective of neurobiology, there is a bidirectional relationship between hormones, neurotransmitters, and behavior. Hormonal and neurotransmitter mechanisms regulate the behavior of individuals, such as anger, stress, and conformity. Consequently, hormones and neurotransmitters are capable to 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 that may underlie conformity.

A hormone is different from a neurotransmitter in a number of respects. The term hormone (e.g., oxytocin, cortisol) often refers to any substances like proteins, lipids, or cholesterol-based molecules that are 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 very fast physiological responses, usually within milliseconds, while hormones take few minutes to 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."

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 then saw the peer confederate decision behavior for probable revision in post versus pre-peer observation. The authors concluded that high testosterone and low cortisol lead to prosocial behavior after observing highly prosocial behavior but remained without change for peers with low-level prosocial behavior. Their results were in agreement with prior studies (Báez-Mendoza & Schultz, 2013; Do, McCormick, Telzar, 2019; Hoorn, Van Dijk, Guroglu & Crone, 2016; Spaans, Peters, Crone, 2019) on social cognition, which indicated observing high prosocial behavior enhances greater activation in the pSTS/TPJ, insula, orbitofrontal cortex (OFC), 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.

The study by Simonsen et al., (2014) examined the role of serotonin in the judgment's alteration of trustworthiness in a facial rating task. Half subjects, who were all females, received a single dose of the selective serotonin reuptake inhibitor (SSRI) 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, subjects 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 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 prior to the task, the experimental group received a single oral dose of methylphenidate (i.e., Ritalin) which increase 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 (OT) is another important natural hormone that can potentially 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.

The aim of the study by Stallen, Dreu, Shalvi, Smidts & Sanfey (2012) was 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 -symbol- on attractiveness when in-group and out-group members express preferences. Prior to 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 And Future Directions

In summary, I have argued in this review how and why individuals are highly sensitive to social influence.

Furthermore, why our everyday actions often can be affected by the choices or opinions of others.

To date, the vast majority of 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 as well as its contagion in prosocial and antisocial activities.

Our brain is a complex system and interconnected network. Future research will need to include an examination of how different parts of the brain 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.

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