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Advances in the Genetic Basis of Social Conformity

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Abstract

Social conformity is important for the formation and maintenance of social norms, which are necessary to help society function smoothly and predictably. Environmental factors, including cultural and social contexts, are the primary determinants of individual differences in social conformity. That social conformity can be influenced by genetic factors has been proposed recently. Different gene alleles, single nucleotide polymorphisms (SNP) or alternative gene splicing, further interacting through, or in conjunction with environment mediated differential gene expression or selection, exert profound effects on social conformity. Gene polymorphisms associated with alcoholism, aggression, stress, anxiety and pathogen prevalence also modulate sensitivity to social influences, which in turn may increase or decrease social conformity. This article specifically summarizes the genetic influence on social conformity arising from sex difference, genetic factors and SNPs. A growing body of evidence supports the premise that not only environmental factors, but also genetic elements play determinant roles in social conformity.

Keywords

Sex difference, Environmental factors, Genetic factors, Social conformity, Single nucleotide polymorphisms, Social influences, Dopamine, Serotonin, Oxytocin, Pathogen prevalence

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Introduction

Social conformity is the act of matching attitudes, beliefs, and behaviors to group norms which are implicit, specific rules shared by a group of individuals on how they should behave (1). Conformity is an essential social mechanism in society, and it influences the formation and maintenance of social norms and helps society function smoothly and predictably via the self-censorship of behaviors seen as contrary to unwritten rules (2). To quote Dr. Muthukrishna, "our whole world is made up of things that we do that are good for us, but we don't know why, and we don't need to know why. We just need to know that most people do those things"(3). If anyone can set their expectations without conformity, then we may create a challenging situation in which it would be difficult for anyone to achieve their goals. Given the importance of conformity for social cohesion and stability, human groups developed these rituals thousands of years ago, and ritualistic synchrony has been thought to promote social conformity (4). Gelfand indicated that synchronous rituals in a group which improved cooperation and cohesion could be adaptive for a group, lending the group an advantage in situations that would require coordination among its members (4). On the other hand, social conformity could discourage minority perspectives during a decision-making tasks as well as decrease creativity (4). For instance, succumbing to peer pressure could result in undesirable behaviors such as underage smoking and limit independence and creativity.

It has been well known that environmental factors, such as cultural and social contexts, are the primary determinant of individual differences in social conformity (5, 6). For instance, Kim et. al. reported that East Asians prefer conformity more than European Americans, likely due to the cultural divergence (6). Additionally, in the Science of Adolescent Risk-Taking workshop organized by the Institute of Medicine and National Research Council Committee on the Science of Adolescence in 2011, several environmental factors were explored that could influence social conformity in adolescents, including their family, peers, schools, communities, media and technology (7). It was found that all of those environmental factors were involved in social conformity in adolescents (7). Despite the important role of environmental factors in social conformity, the genetics and heritable factors that influence social conformity have been increasingly investigated in recent years. This review specifically focuses on the advances in attributing genetic influences arising from sex difference, genetic factors and single-nucleotide polymorphisms (SNPs) on social conformity.

Discussion

Sex and social conformity

Sex differences in social conformity has been extensively researched. In the pressure conformity experiments in which subjects receive the opinions of other group members and are influenced to the extent that they change their opinions to match those of the other members, it was observed that women tended to conform more than men (8, 9). In

contrast, Maccoby and Jacklin (10) reported no sex differences in most Asch situation conformity experiments where a series of psychological experiments were conducted by Solomon Asch in the 1950s to reveal the degree to which a person's own opinions are influenced by those of a group (10). It was argued that such controversy could rise from experimental task difficulty since results consistently showed that conformity was increased as the task difficulty increased, and the visual-spatial judgments in the Maccoby and Jacklin's report were generally difficult (11, 12). Another task-related influence on sex differences on conformity involved the "gender-appropriateness" of the task. Sistrunk et. al. reported that males were more conforming on traditionally feminine opinion items, while females were more conforming on traditionally masculine items (13). Moreover, in studying opinions about the length of patient hospitalization in male and female introductory psychology students, Hansson et. al. found that males were least influenced by the opinions of their peers but became increasingly influenced as the source became more expert, whereas females seemed most influenced by their peer group (14).

Though important roles of sex difference in social conformity have been extensively studied, no reports have attributed such sex differences to genetics. Sex is determined by sex chromosomes, which contain genetic information. Humans have two sex chromosomes, X and Y, and their combination determines the sex of an individual. Males have one X and one Y chromosome, whereas females have two X chromosomes in their cells. Therefore, social conformity difference between males and females could prima facie be attributed to the sex genetic difference in males and females.

Genetic factors and social conformity

In 2008, Agrawal and colleagues studied genetic and environmental influences contributing to individual differences in alcohol drinking expectancies and motives (15). In this report, conformity (drinking as part of a group) as one drinking motive factor was studied by collecting questionnaires from 3656 young adult female twin alcohol users including 767 monozygotic (MZ) and 638 dizygotic (DZ) twin pairs, and 439 individual twins. It is known that MZ twins share all their genetic sequence identities and DZ twins share only 50% of genetic identity on average. The study results showed that genetic factors contributed to appropriately 22% of the total variance in conformity motives (15).

As social values are associated with stronger group identification and a higher need for affiliation, which are positively related to social conformity (16), Schermer et. al. examined how relations between social values and personality (including restrictive conformity) were attributable to shared genetic or environmental factors (17). They recruited 258 adult sibling pairs with an average age of 24 years. Among the participants, there were 148 monozygotic (MZ) female twins, 38 MZ male twins, 82 dizygotic (DZ) female twins, 18 DZ male twins, and 30 DZ opposite-sex twins, 104 non-twin sisters, 32 brothers, and 64 opposite

sex non-twin siblings. In this study, seven value scores (enjoyment, achievement, self-direction, maturity, prosocial, security, and restrictive conformity) were derived in twins. The result indicated that all value scales were strongly associated with a genetic component (17).

It is believed that the ability of individual religiosity can predict adherence to the law, absence of alcohol and drug abuse, and obedience to other social norms (18, 19). In 2008, Bradshaw et. al. reported a study of genetic factors influencing religiosity (20). They analyzed twin sibling data from the National Survey of Midlife Development in the United States and found that the individual-level variation in religious life on four different aspects (organizational involvement, personal religiosity and spirituality, conservative ideologies, and transformations and commitments) is indeed influenced by both genetic and environmental influences (20). In particular, 19-65% of the individual-level variation could be explained by genetic factors, whereas environmental influences were responsible for the rest of the individual-level variation in religion.

Genes and social conformity

Studying genetic influence on social conformity has recently advanced to gene single-nucleotide polymorphisms (SNP). SNPs are a germline substitution of a single nucleotide at a specific position in the genome to pinpoint differences in our susceptibility to a wide range of diseases (21). In 2017, Chen and colleagues analyzed 1,140 twins and SNPs-based studies of 2,130 young adults (22). They did a genome-wide association study (GWAS) which identified replicable associations in 9 genomic loci, followed by a meta-analysis of three GWAS with a sample size of ~2,600. Their study confirmed one locus where the Neuron Navigator 3 (NAV3) gene encodes an essential protein for axon outgrowth. The study further demonstrated that genes such as NAV3, protein tyrosine phosphatase receptor type D (PTPRD), ADP ribosylation factor-like GTPase 10 (ARL10), and catenin delta 2 (CD2) were strongly associated with social conformity (22). By using functional magnetic resonance imaging (fMRI), Chen et. al. imaged brains of 64 subjects, and showed a correlation of activation or structural features of brain regions with the SNPs of NAV3, PTPRD, ARL10, and CD2 genes, supporting the concept of genetic elements' influence on social conformity (22).

Oxytocin is a nine-amino acid long peptide hormone encoded by oxytocin gene, and oxytocin binds to the oxytocin receptor (OXTR), a G protein-coupled receptor, to modulate various biological functions including human social behaviors (23, 24). Stallen et. al. and colleagues examined whether conformity toward one’s in-group is altered by oxytocin (25). After administration of either oxytocin or a placebo, participants were required to provide attractiveness ratings of unfamiliar visual stimuli. The result showed that the ratings of the participants who received oxytocin conformed to the ratings of their in-group but not of their out-group, while the participants received a placebo did not show this in-group bias, suggesting that oxytocin

administration influence subjective conformity (25). In addition, Huang et. al. examined whether oxytocin treatment can influence social conformity to either in-group or out-group opinions in a double-blind, placebo-controlled design experiment (26). They found that oxytocin improves conformity to opinions of both in- and out-group members when social pressure is implicit, suggesting that oxytocin facilitates 'tend and befriend' behaviors by increasing the general level of social conformity (26). Oxytocin's effects on social conformity may be mediated by oxytocin receptors in the striatum, the brain area involved in reward processing (27). In animal models, chronic oxytocin administration drives alternate splicing of the anxiety modulator, corticotropin releasing factor receptor 2α (crfr2α); shifting the splicing ratio from the anxiolytic membrane-bound (mCRFR2α) form of CRFR2α towards the anxiogenic soluble CRFR2α (sCRFR2α) form (28).

Dopamine is an important neuro-modulatory molecule in cells, and a recent study reported that enhancement of dopamine responses by methylphenidate drug promotes social conformity to group opinion (29). As dopamine release is associated with a specific SNP of the dopamine receptor 3 genes, Zhao and colleagues investigated to what extent this specific SNP of the dopamine receptor 3 gene affects social conformity (30). They recruited 152 Chinese students in the study and categorized them according to the SNP of dopamine receptor 3 genes, and tested them with a conformity test and facial-attractiveness rating task test (30). Their study showed that individuals with a greater number of this specific SNP related to an increased dopamine release in the striatum, were more susceptible to social influence and more likely to change their ratings to match other people, suggesting that the importance of the specific SNP of dopamine receptor 3 genes as an important genetic factor for social conformity (30). In addition, the serotonin transporter gene (SERT or 5-HTT) encodes serotonin transporter protein that transports serotonin from the synaptic cleft back to the presynaptic neuron (31). The short (s) allelic variant of the serotonin transporter-linked polymorphic region (5-HTTLPR) is associated with reduced 5-HTT protein expression and function (32). It was reported that harboring the s variant of the 5-HTTLPR is associated with improved cognitive functions and social conformity in humans and nonhuman primates (33).

In contrast, a completely opposite result; i.e. that there was no genetic influence on conformity was reported by Li and colleagues (34). They designed a social episode to investigate the genetic and environmental origin of individual differences in conforming behavior during psychosocial development (34). They studied 107 monozygotic (MZ) twins and 74 dizygotic (DZ) twins aged 7–19 years old, who were asked to choose a pen from a group of pens either with the majority color or with the minority color. The result showed that the resemblance between MZ twins in selecting the pen with the majority color was not significantly higher than that between DZ twins, suggesting that there was no genetic influence on conformity (34). This

contradictory result, along with other studies is interesting and worthy of further investigation. Li et. al. attributed the resulting discrepancy to the implicit measure method, which is different from the self-report measure method used in other studies.

Genetic Factors that indirectly influence social conformity

As social conformity could be influenced by other social behaviors (such as alcoholism, aggression, stress and anxiety), the genetics underlying those social behaviors could indirectly impact social conformity. For instance, Gamma-aminobutyric acid receptor subunit alpha-2 (GABRA2) gene is associated with the differences in the subjective effects of alcohol and the variance in drinking behavior (35, 36). In multiple twin studies, aggression has been reported to be heritable (37-39), and genetics accounts for approximately 40–50% of the risk of aggressive behavior (37, 40). Many genes associated with aggression have been reported including Estrogen receptor genes (ESR1 and ESR2), androgen receptor gene, SLC6A3 gene (encoding the dopamine transporter) (41-45). Moreover, genes and their SNPs have been investigated in stress and anxiety as well, and several neurotransmitter- and neuropeptide-related genes (HRT2A, SLC6A3, DRD3, NPY, CNR1, and RGS2) have been found to be associated with stress and anxiety (46-48). FK506 binding protein 5 gene (FKBP5P) is another gene that has been linked with stress and anxiety, and its variant plays an important role in stress-related phenotypes and disorders (49-51).

Pathogen prevalence has been hypothesized to influence genetic transmission. This hypothesis posits that specific alleles associated with conformity may have been differentially selected for, or differentially expressed, within populations characterized by relatively high levels of pathogen prevalence (collectivist societies), whereas alleles associated with nonconformity may have been more likely to proliferate within populations characterized by relatively low levels of pathogen prevalence (individualistic societies) (52). A possible candidate for such an allele may be the 5-HTTLPR polymorphic region of the SLC6A4 serotonin transporter gene. As described earlier, the S allele of the serotonin transporter is associated with better adaptability to living conditions under conditions of increased danger (53), i.e. in pathogen prevalent or collectivist regions, which is indirectly confirmed by the greater and lesser frequency of occurrence of this allele across collectivist and individualistic ethno-regional cultures respectively (54).

In addition, a host of genetic variants that increase sensitivity to social cues may predispose individuals to be more sensitive to social rewards or punishments, which in turn increases conformity and susceptibility to normative social influences. Some of these are listed in Table 1, directly adapted from reference 55. Furthermore, the genes associated with the personality traits of addiction, risk taking and impulsivity have also been reported to influence the responsiveness to stress (56). Unsurprisingly, they overlap those genes listed in Table 1.

Table 1: Genetic variants implicated in the modulation of behavioral sensitivity to social influences (directly adapted from reference 55)

Polymorphism	Gene	Putative cellular effect	Main reported neural effect	Emerging evidence of differential susceptibility
DAT 3′ VNTR	Dopamine transporter (*SLC6A3*)	9-repeat allele, lower gene expression	Increased striatal reactivity to reward-related stimuli	Increased paralimbic reactivity during conflict tasks
COMT val^{158}met	Catechol-*O*-methyl-transferase (*COMT*)	Met allele, less enzyme activity, higher synaptic dopamine	Met allele associated with greater neural activity to reward-related stimuli	Met allele associated with greater anxiety, greater neural activity during negative emotion processing, and greater pain reactivity
MAOA-uVNTR	Monoamine Oxidase A (*MAOA*)	Low expression allele, reduced gene expression	Low expression allele greater paralimbic reactivity to negative stimuli	Some evidence for greater sensitivity to positive stimuli as well
A118G	μ-Opioid Receptor (*OPRM1*)	G allele associated with reduced gene expression	Increased paralimbic reactivity to negative stimuli	Increased activation in reward-related areas to reward and rewarding cues
STin2	Serotonin Transporter (*SLC6A4*)	10 allele less efficiently transcribed than 12 allele *in vitro*	Increased amygdala response to persuasive smoking-cessation messages in smokers	TBD
5-HTTLPR	Serotonin transporter (*SLC6A4*)	Short allele decreased gene expression in lymphoblasts	Increased amygdala reactivity to negative stimuli	Increased left lateralized neural activity in response to positive stimuli

Conclusion

Social conformity is a characteristic of every society and generally has the effect of achieving social cohesion and stability. For instance, social conformity can persuade people to follow established social norms and conventions, meet social obligations and expectations, and match attitudes, beliefs, and behaviors to those generally practiced. However, social conformity has its limitations, such as weakening individual creativity and energy. Environmental factors including cultures, social contexts and religions have long played critical roles in defining and perpetuating social conformity. Recently, the genetic basis of social conformity has been explored, with multiple genes and their SNPs found to influence this trait. For instance, the SNPs of NAV3, PTPRD, ARL10, CD2, and dopamine receptor 3 genes have been reported to play important roles in influencing social conformity, although evidence to the contrary has also been reported in the literature. However, an overwhelming body of evidence supports the premise that not only environmental factors but genetic elements as well play determining roles in social conformity. Studying the genetic factors that influence social conformity will significantly help increase our understanding of social conformity in contemporary social science.

Abbreviations

MZ— monozygotic
DZ— dizygotic
SNP— single-nucleotide polymorphisms
GWAS— genome-wide association study
NAV3— Neuron Navigator 3
PTPRD— protein tyrosine phosphatase receptor type D
ARL10— ADP ribosylation factor-like GTPase 10
CD2— catenin delta 2
fMRI— functional magnetic resonance imaging
RSB— Risky Sexual Behavior
FKBP5P — FK506 binding protein 5 gene
ESR— Estrogen receptor
SERT— Serotonin transporter
5-HTTLPR — Serotonin transporter-linked polymorphic region
GABRA2— Gamma-aminobutyric acid receptor subunit alpha-2
crfr2α — corticotropin releasing factor receptor 2α
SLC6A4 — Solute carrier family 6 member 4
HRT2A — 5-Hydroxytryptamine receptor 2A
SLC6A3 — Solute carrier family 6 member 3
DRD3 — Dopamine receptor D3
NPY— Neuropeptide Y
CNR1 — Cannabinoid receptor 1
RGS2 — Regulator of G-protein signaling 2
OXTR — Oxytocin receptor

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