GENETIC ATTRIBUTIONS, BEHAVIOR, AND WELL-BEING:

A PSYCHOLOGICAL STUDY OF FREE WILL BELIEFS

A Thesis

by

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ABSTRACT

During the last decades, genetic information has become increasingly available and accessible. Because of this increase in availability, it is important to understand the psychological impact genetic testing has on consumers and its potential social and ethical implications. The purpose of this study was to examine how genetic beliefs might interact with behavior to influence the broader belief in free-will. Three hundred sixty-nine undergraduate participants were asked to provide a saliva sample, which was used as a deceptive mechanism, and were subsequently randomly assigned to learn that they possessed a gene variant that was associated with either risk-taking or risk-avoidance. Afterward, they completed a behavioral measure of risk-taking and a measure of free-will beliefs. Our results indicated that participants in the positive risk genetic feedback condition scored significantly higher on the risk-taking behavior measure compared to the participants assigned to the negative risk genetic feedback condition. However, the congruence between behavior and genetic feedback was not associated with a diminished perception of overall free-will amongst participants. We conclude that, even though the connection between genetic attributions and personal agency needs further investigation, our study provides additional evidence for the importance of genetic information by replicating the effect of genetic beliefs on behavior and contributes to the literature by showing that those effects are not limited to concrete, health-related, or stigmatized outcomes, or to variables with a strong expectation of heritability.

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All other work conducted for the thesis was completed by the student independently.

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TABLE OF CONTENTS

1. INTRODUCTION

1.1. Psychology of Free Will Beliefs

Free will in psychology is no longer a metaphysical concept. With the advent of modern neuroscience and the increasing understanding of cognition, the concept of free will has become outdated and any metaphysical account of free will is generally rejected in psychological science (Brembs, 2011). Today, when discussing free will, we are no longer talking about a metaphysical, abstract idea "according to which human souls float free above the mechanistic constraints of the physical world", but, rather, "an embodied free will, tethered to biology, that encompasses our ability to respond to complex circumstances in complex and unpredictable ways and in the process to build a self" (Turkheimer, 2011, p. 826). This way of looking at free has offered an empirical start point from which psychologists could start making claims about whether people "have a choice" or are "determined" in their behavior.

Initially, free will was addressed in psychology by invoking different notions, such as self-regulation, controlled processes, behavioral plasticity, and conscious decision-making (Baumeister, 2008). More recently, psychologists have also investigated how people define or understand free will (e.g., Monroe & Malle, 2010; Stillman, Baumeister, & Mele, 2011), as well as individual differences in free will beliefs (e.g., Paulhus & Carey, 2011).

It is important to note that a multitude of psychological research casts doubt on the very existence of free will by looking at the direct causes of action for behavior. Many have shown that factors outside of conscious awareness, functioning mostly as unconscious and automatic processes, assert a greater causal influence on actions than free conscious choosing, even when those actions might be perceived as “free” (e.g., Bargh, 1994; Libet, 1999; Wegner, 2002; Wilson, 2002, as cited in Baumeister, 2008). In fact, according to Baumeister (2008), “the fact that automatic, nonconscious processes are the direct causes of action seems now well established and has dealt a severe blow to some theories of conscious free will” (p. 15).

Bargh (2008) offers a review of scientific evidence for the fact that the causes of action and experience are mainly unconscious, instead of conscious. Examples of such phenomena are the fact that evaluation of novel objects happens automatically and is immediately connected to automatic behavioral (motoric) tendencies, as well as the fact that brain-wave impulses to act precede conscious awareness of the intention to act. Moreover, Bargh (2008) describes how people’s unconscious goal pursuit over time can happen in the absence of ability to accurately self-report on one’s intentions, how people unconsciously mimic others’ behavior, and, overall, how people’s conscious self-regulatory capacity is surprisingly scarce (p. 148) to support the overarching argument that while the phenomenological feeling of free-will seems very real, free-will itself as a determinant of behavior is illusory (p. 149).

The question, of course, remains whether conscious control or awareness are to be equated with free will. Most likely, the answer must be no, since “even behavior that subjects believe to be completely under conscious control is influenced by external factors” (Baer, Kaufman, & Baumeister, 2008, p. 221). Nonetheless, one has to keep in mind that those studies do not provide conclusive evidence against free-will. After all, the fact that behavior is not under utter conscious control, but influenced by external factors, does not disprove the existence of free choice. In fact, according to Baumeister

(2008), “the deterministic hypothesis—that every event is fully and inevitably caused by prior events and nothing else than what happened was ever possible—is itself unproven and even unprovable, so it requires a big leap of faith” (p. 15). Even though every action might not be under conscious control, that is not to say that free will is never exercised.

Psychological inquiry into the existence of free-will has thus hit a perhaps predictable roadblock. Yet, regardless of whether free will exists or not, people’s beliefs about free will, as well as the ways that those beliefs might impact their cognition and behavior, in spite of whether they are correct, plausible, or justifiable by facts, are real and very much within the expertise of psychologists (Baumeister, 2008). In fact, an important contribution to the evolution of the concept of free will within psychology was made by Vohs and Schooler (2008), who brought back the concept of free will and initiated an innovative direction by addressing it directly and experimentally. They avoided contributing to the debate about the existence of free will, and instead focused on the belief in free will by manipulating people’s beliefs in it. As they had foreseen, they found that people’s behaviors changed as a result of being induced to believe or not believe in free will (Baumeister, 2012).

Later on, Feldman (2016), defined the belief in free will as a core belief that views humans as free from both external constraints (e.g., luck, fate, God, the environment, society, other agents) as well as internal deterministic factors (e.g., urges, needs, genes, personality, affect). According to Feldman (2016), “people differ in their beliefs regarding the human capacity for choice; some people view their behaviors and lives as a consequence of their own agentic free choice, whereas others believe that they are deterministically guided by internal factors that are beyond their control, such as their upbringing, personality, or genetics, or by externals factors such as God, nature, science, or fate" (p. 2). Importantly, different free will beliefs predict widely different variables, and have been found to have numerous consequences for behavior and well-being. As a consequence, the "debate over free will has societal, as well as scientific and theoretical implications" (Vohs & Schooler, 2008, p. 49).

The belief in free will is widespread and intuitive. Often, people feel that they are "making a choice in which more than one outcome is possible" (Dewall, Baumeister, & Masicampo, 2008). This widely spread belief in free will has essential implications for the way society functions. For example, religious beliefs, particularly but not only in the Western culture, emphasize the existence of free will as a central element of human life. Thus, punishment and salvation are granted on the basis of the freely chosen acts of virtue or sin.

Notably, the importance of free will belief for retributive purposes does not end with religious beliefs or practices but has tangible consequences in the real world. The legal system also allocates guilt and punishment differentially based on perceptions of the rule breaker's capacity for free choice (Baumeister, et. al., 2009), with perceived reductions in the capacity for free choice functioning as valid reasons for reduced punishment or even acquittal (Baumeister, et. al., 2006, p. 260,). In fact, a series of studies done by Shariff (2014) demonstrated that "people with weaker free-will beliefs endorsed less retributive attitudes regarding punishment of criminals, and that mere exposure to modern neuroscience can be sufficient to reduce retributivist motivations and attributions of moral responsibility" (p. 7).

While the focus on free will might be especially evident in the Western culture, where people share a belief in human freedom of action (Baumeister, 2009), the implications of free will beliefs seem to surpass cultural barriers and depict a feature of the human condition. For example, Brembs (2011) studied invertebrate models in order to draw conclusions about the neurobiological basis of decision-making and concluded that the belief in free will has an important, positive, and functional role for the self in adaptation and survival (cited in Feldman, et al., 2016). Dennett (2003) and Hume (1748) also argued that free will beliefs play a role in the pursuit of what a person wants or needs.

Furthermore, belief in free will also plays an important role in the coordination with others in society and general involvement in prosocial behavior. Specifically, Baumeister, Masicampo and DeWall (2006) found that belief in free will requires, to a certain extent, thoughtful reflection, as well as a willingness to exert energy, which promote helpfulness and reduce aggression among lay people. Similarly, free will beliefs seem to lead to more honest behavior (Vohs & Schooler, 2008). On the other hand, disbelief in free will seems to rely on more selfish, automatic impulses that lead to less socially desirable behaviors, such as reduction in the willingness to help and increased aggression. Strikingly, Vohs and Schooler (2008) found that even a brief exposure to a message asserting that there is no such thing as free will can increase both passive and active cheating, which raises the concern that "advocating a deterministic worldview could undermine moral behavior" (p. 53).

Free-will belief has also been found to have numerous important implications for behavior and well-being. For instance, belief in free will has the potential for improving subjective well-being, whereas belief in determinism or fate lowers subjective well-being (Carey & Paulhus, 2013; Kondratowicz-Nowak & Zawadzka, 2018). Additionally, free will believers were found to be more satisfied with life, have more positive emotions, and feel healthier than those who held more deterministic views (Crescioni, Baumeister, Ainsworth, & Lambert, 2016; Kondratowicz-Nowak & Zawadzka, 2018; Li, Wang, Zhao, Kong, & Li, 2017). Belief in free will is also associated with a sense of belongingness, which facilitates greater meaningfulness (Moynihan, Igou & Tilburg, 2017), and gratitude (MacKenzie, Vohs & Baumeister, 2014). Following such findings, some researchers argued that there is a need to develop and promote belief in free will in societies and social policies as a means to increase general well-being (Kondratowicz-Nowak & Zawadzka, 2018, p. 109).

The link between belief in free will and self-regulatory success would certainly support such arguments. That is, belief in free will contributes to autonomous action, resisting temptations and pressures to conform. In a study done by Alquist, Ainsworth & Baumeister (2013), people who habitually had higher levels of belief in free will reported lower conformity across a broad variety of everyday situations. Additionally, experimentally reduced free will beliefs caused increases in conformity. Similarly, free will beliefs predicted higher perceived ability and positive attitudes toward decision making (Feldman, Baumeister, & Wong, 2014). Moreover, belief in free will seems to also predict perseverance for long-term goals (Li, Zhao, Lin, Chen, Wang, 2018), self-efficacy and less suffering from helplessness (Baumeister & Brewer, 2012), as well as lead to better academic and job performance (Feldman, Chandrashekar and Wong, 2016). Feldman, Chandrashekar and Wong (2016) found that individual differences in the endorsement of the belief in free will are a significant and unique predictor of academic achievement. In a similar fashion, Stillman, Baumeister, Vohs, Lambert, Fincham and Brewer (2010) reported that the effect of free will beliefs on job performance indicators was significant and independent of other well-established predictors (e.g., conscientiousness, locus of control, work ethic), with stronger belief in free will corresponding to more positive attitudes about expected career success, and employees who believed in free will receiving better performance evaluations from supervisors than those who disbelieve in free will.

In conclusion, extant research indicates that, regardless of the reality of free will, beliefs in free will are malleable, and have observable psychological, moral and societal implications. Free-will beliefs underlie perceptions of moral responsibility (e.g.; Eshleman, 2004 and Nahmias et al., 2005, as cited in Shariff, 2014), and play an important role in well-being (Carey & Paulhus, 2013; Kondratowicz-Nowak & Zawadzka, 2018; Paulhus & Carey, 1994), social coordination and prosocial behavior (Baumeister, Masicampo, & DeWall, 2006), adaptation and survival (Brembs, 2011), autonomous action (Alquist, Ainsworth & Baumeister, 2013), decision making (Feldman, Baumeister, & Wong, 2014), goal pursuit (Li, Zhao, Lin, Chen, Wang, 2018), etc., which suggests that it might be an important, fundamental aspect of the human condition.

1.2.Genetic Attributions and Personal Agency

Since the first genome was sequenced in 2013, genetic information has become increasingly available and accessible. People can now peer into their genetic makeup and access information about themselves that no previous generation could ever before

(Heine, 2018). Their genomes can tell them incredible things, including insight into who their ancestors were (Akpan, 2017), what kind of psychological and physical attributes they are predisposed to have (Heine, 2018), and even their political attitudes, religiosity, vocational interests and phobias (see Bouchard, 2004, for a review). While there are certainly advantages to having access to this information, there may also be downsides in the sense that evidence for genetic contributions to personal characteristics might undermine a person's sense that those characteristics are determined. Free-will and determinism, or the philosophical belief that all events are determined completely by previously existing causes (in this case, genes), have often been viewed as opposites. One of the most popular measures of free will belief in psychology, the Free Will and Determinism Scale (FWDS; Rakos, Laurene, Skala, & Slane, 2008), treats determinism as the polar opposite of free will, such that increases in one belief correspond to decreases in the other (Baumeister, 2012). This antagonistic relationship between free-will and determinism may be especially strong in lay people's reasoning about genes.

There is a multitude of research showing that when people are exposed to information that a characteristic has a genetic component, they tend to adopt a biased mindset characterized by greater beliefs that the characteristic is uncontrollable, immutable, discrete, and determined entirely by genes (Dar-Nimrod & Heine, 2011). They come to see the gene as the "essential" cause of the characteristic. As described by Vess, Brooker, Stichter and Neiderhiser (2018) in a sister project, "this orientation, referred to as *genetic essentialism*, is characterized by four defining qualities. First, people view the heritable characteristics with a sense of fatalism, believing that possessing the gene makes possession of the characteristic uncontrollable and determined. Second, people tend to see the heritable characteristic as fundamentally caused by genes. This means that people view characteristics that are described in terms of their genetic origins as relatively less influenced by social or environmental forces. Third, people see those who possess the gene as members of a distinct group and those who do not possess gene as unlikely to possess the characteristic linked to the gene. Fourth, and finally, characteristics described in terms of genetics are viewed as natural, implying in many cases that they are "good" because they follow a natural tendency." (p. 170). Fundamentally, when people are exposed to an argument that has a genetic basis, they tend to experience an essentialist bias that "leads people to adopt stronger views that the phenomena are natural, immutable, discrete, and solely caused by genetic influence" (Vess, et al., 2018, p. 170).

Critically, the adopted "genetic essentialist" orientation produces a cascade of downstream consequences, many of which are suggestive of a diminished sense of personal agency. Research indicates that people implicitly associate genes with fate more than they do with choice, and according to Gould and Heine (2012), these implicit associations can help explain the essentialist reactions that people show when encountering genetic concepts (p. 3). Not surprisingly, genetic attributions are also associated with conscious feelings of personal control. For instance, genetic attributions for the etiology of illness were found to be associated with decreased personal control over that illness (Sheldon, 2017). Similarly, an increased perception of genetic etiology leads to a reduction in the sense of personal agency and ultimately the sense that one can choose freely in an unconstrained manner (Dar-Nimrod & Lisandrelli, 2012). More broadly, numerous studies have investigated the relationship between genetic attributions and various negative health-related characteristics, including individual's inactivity (Beauchamp, Rhodes, Kreutzer, & Rupert, 2011), weight (Dar-Nimrod, Cheung, Ruby, & Heine, 2014; McVay, Steinberg, Askew, Kaphingst, & Bennett, 2016; Wang & Coups, 2010), nicotine dependence (Wright, Weinman, & Marteau, 2003), and susceptibility to alcoholism (Dar-Nimrod, Zuckerman, & Duberstein, 2013), finding a negative relationship between genetic attributions and perceived personal control.

The effects of genetic etiology beliefs on feelings of personal control may also extend to actual behavior by instilling a set of expectations that guide people towards responses in line with those expectations (Turnwald, Goyer, Boles, Silder, Delp, & Crum, 2018). For example, Bloss, Schork, and Topol (2011) found that receiving a higher genetic risk result for obesity leads to unhealthier dietary intake and decreased exercise three months later. Similarly, Lineweaver, Bondi, Galasko, and Salmon (2014) found that informing older adults that they have an APOE genotype associated with an increased risk of Alzheimer's disease can have adverse consequences on their performance on objective memory tests. A recent study by Turnwald et. al (2018) tested whether merely learning one's genetic risk for disease alters one's actual risk for that disease. To answer this question, they genotyped individuals for actual genetic risk and then randomly assigned them to receive either a "high-risk" or "protected" genetic test result for obesity. The results were astonishing: "merely receiving genetic risk information changed individuals' cardiorespiratory physiology, perceived exertion, and running endurance during exercise, and changed satiety physiology and perceived fullness after food consumption in a self-fulfilling manner" (Turnwald et. al, 2019, p. 1). Many of these effects occurred above and beyond the influence of participants' actual genetic risk as indexed by the genotyping. In sum, there is evidence to indicate that genetic beliefs can be impactful enough to causally impact actual behavior.

1.3.Purpose of the Study

Although the extant research indicates that genetic beliefs can diminish perceived control and produce placebo-like effects on behavior, no research has examined how genetic beliefs might interact with behavior to influence the broader belief in free-will. The goal of this study was to do just that. We randomly assigned participants to learn that they possessed a gene-variant for a complex characteristic that we posited to be relatively neutral in desirability: risk-taking. Participants were induced to believe that they possessed a gene variant that was associated with either risk-taking or risk-avoidance. Afterwards, they completed a behavioral measure of risk-taking and a measure of free-will beliefs. We had two specific hypotheses that we intended to address.

Primary Hypothesis 1. Our first hypothesis was that *people who were given genetic feedback indicating that they are genetically disposed to risky behavior would demonstrate higher risk-taking behavior than those who received feedback indicating that they are genetically disposed to risk aversion.* This hypothesis follows logically from the findings of earlier research on the effects of genetic feedback on behavioral outcomes. However, to our knowledge, no study has examined the effect of genetic feedback on risk taking behavior.

Primary Hypothesis 2. Our second hypothesis *was that risk-taking behavior would interact with participants' genetic feedback condition to predict beliefs in free-will*. We expected that an incongruence between behavior and genetic feedback would be associated with a greater perception of free-will. That is, for people relatively high in risk taking, those in the risk aversion gene condition would report higher free-will beliefs than those in the risk-taking gene condition. For those low in risk taking behavior, those in the risk-taking gene condition would report higher free-will beliefs than those in the risk averse gene condition. This hypothesis was grounded in the idea that participants whose genetic feedback was incongruent with their actual risk-taking behavior would feel that they were able to somehow override the genetic influence, which, in turn, would enhance their perception of free will.

2. METHOD

2.1. Participants

Introductory psychology students (*N* = 369; M_{age}= 18.82, SD_{age}= 1.29) at Texas A&M University participated for partial course credit. These participants identified as male (*N* = 90), female (*N* = 277)**,** or did not provide a gender identification (*N* = 2). Our sampling plan was to recruit as many participants as possible during an academic term, targeting about 200 participants per condition. Despite data being collected over the course of three academic semesters, we were not able to reach the target sample size. We recruited male and female participants who are 18 years of age or older. No other inclusion or exclusion criteria were utilized.

2.2. Procedure

Phase 1

Participants signed up in the Sona system, a cloud-based participant management software, for a two-part study; they had to choose two different dates to come to the lab, that were set two weeks apart. Participants arrived at the lab in groups of 1 to 3. A trained experimenter greeted the participants and provided the introduction to the study. The study was described as being focused on genes and personality characteristics. The researcher explained that we were interested in how specific genes relate to self-reported personality, and that the study involved filling out some standard personality measures and providing a saliva sample that we would utilize for genetic testing for a certain genetic profile associated with aspects of personality. Participants had an opportunity to ask questions during this initial introduction and were given an information sheet about their rights as participants.

If participants agreed to participate, they were ushered into private computer cubicles in a separate testing room and completed a number of survey measures not central to our primary hypotheses. After completing the Phase 1 survey, they were asked to provide a saliva sample. The experimenter handed participants a saliva sample kit, which included two synthetic cotton swabs in a sealed plastic tube and instructed them to swab the inside of their mouths and place the swab back into the tube and close it. The experimenter then confirmed the name of the participant and wrote a random number on the tube. When finished, participants were told that they should receive an email in a few weeks notifying them that the laboratory analysis was complete, and they could come to retrieve the results. The saliva sample was never sent for analysis but only used as a deceptive mechanism.

Phase 2

Two weeks later, participants returned to the laboratory to receive the bogus saliva test results and were informed that they possessed a gene variant that predisposed them to behave in a risky or risk-avoidant fashion. Participants were handed their random saliva test results, which were enclosed in a white envelope with their name on it. Participants read that they either possess a 7R+ variant of the DRD4 gene (indicating higher levels of risk-seeking), or a 7R- variant of the DRD4 gene (indicating lower levels of risk-seeking). On the computer screen, participants in both conditions read the following paragraph:

> "The Dopamine receptor D4 gene (DRD4) has been previously linked to risk-taking propensity. Previous studies about behavioral traits and the *DRD4* gene revealed that individuals with a specific variant of the DRD4 gene (7R+) are

more risk-seeking than people without it (7R−), which makes them prone to take more risks in specific situations that may cause positive stimulation, (e.g., gambling, practicing extreme sports, migration, novelty seeking).

Subsequently, participants were asked to type in their identification number, which led them to a different screen explaining that according to our records and the information they introduced in the system, they possessed either the 7R+ or 7R- variant of DRD4, as well as providing them an explanation of what that meant in terms of their proneness to risk taking, relative to the average individual. Following the receipt of the saliva test results, participants completed all the Phase 2 measures, which included a measure of free will. Lastly, participants received a formal debriefing that detailed the broad goals of the project and debunked the deception involved.

2.3. Measures

Phase 2 Measures

Automatic Balloon Analogue Risk Task (Automatic BART). Participants completed the Automatic BART (Pleskac, et al., 2008), a computerized, laboratory-based measure that involves actual risky behavior for which, similar to real-world situations, riskiness is rewarded up until a point at which further riskiness results in poorer outcomes. In the task, the participant was presented with a balloon and offered the chance to earn points by pumping the balloon up. All participants saw the same balloons in the same order to limit extraneous variability (Pleskac, Wallsten, Wang, & Lejuez, 2008). According to Pleskac et al. (2008), the task asks participants to "simply type the target number of pumps they wish to take at the beginning of a trial. Once they accept this value, participants watch the balloon as it automatically expands until either the stated number of pumps is reached or it explodes". Thus, each pump confers greater risk, but also greater potential reward. Participants were informed that they could earn the most points on average if they pumped 64 times on each trial (Lejuez et al., 2002).[1] For means and standard deviations on the Automatic Balloon Analogue Risk Task see Table 1 in the Appendix.

Free-will and Determinism Scale. The FAD–Plus (Paulhus & Carey, 2011) is a 27-item measure of lay beliefs in free will and 3 closely related constructs: scientific determinism, fatalistic determinism, and unpredictability. Participants responded to items (e.g., "Chance events seem to be the major cause of human history"; "People have complete free will") on a 1 (strongly *disagree*) to 5 (strongly *agree*) scale. Paulhus & Carey (2011) provided support for the structure and construct validity of the scale and reported alpha reliabilities for each construct as follows: Free Will, .69; Scientific Determinism, .69; Fatalistic Determinism, .82. In this study, the overall reliability of the scale was strong ($\alpha = .732$). For means and standard deviations on the Free-will and Determinism Scale see Table 1 in the Appendix.

Demographics. Participants completed a series of standard demographics questions, including gender, race, age, and place of origin. They also completed a data integrity check item at the very end of the survey.

[1] Participants also completed other measures, but they were not my focus in this specific inquiry into the effects on free-will beliefs.

3. RESULTS

3.1. Effect of Condition on Risk Behavior

The 174 participants in the positive risk genetic feedback condition (*M* = 1992.03, *SD* = 435.71) compared to the 182 participants assigned to the negative risk genetic feedback condition (*M* = 1777.58, *SD* = 466.82) displayed significantly higher scores on the risk taking behavior measure, $t(354) = -2.39$, $p = .017$, 95%, CI [-208.68, -20.22], $d = 0.25$. In other words, participants who were given genetic feedback indicating that they are genetically disposed to risky behavior demonstrated higher risk-taking behavior than those who received feedback indicating that they are genetically disposed to risk aversion.

3.2. Interactive Effect of Condition and Risk Behavior on Free Will Beliefs

Regression analyses were conducted to test our second hypothesis. We entered the main effects of Genetic Feedback (dummy coded: 0 = Risk Taking, 1 = Risk Averse) and BART behavior (mean-centered) in Step 1, followed by the interaction in Step 2. There was no significant main effect of Genetic Feedback ($\beta = 0.04$, $t(353) = 0.81$, $p = .422$) or Bart behavior ($\beta = -.08$, $t(353) = 1.40$, $p = .164$). There was also no significant interaction ($\beta = -.09$, $t(352) = 1.10$, $p = .274$).

We performed the same analysis for the free will subscales and found no significant results. Specifically, for the scientific determinism subscale, there was no significant main effect of Genetic Feedback ($\beta = -0.04$, $t(354) = 0.73$, $p = .942$) or Bart behavior ($\beta = .02$, $t(353) = 2.9$, $p = .78$). There was also no significant interaction ($\beta = -.04$, $t(352) = .49$, $p = .628$). For the fatalistic determinism subscale, there was also no significant main effect of Genetic Feedback (β = .06, $t(354) = 1.19$, $p = .235$) or Bart behavior (β = -.10, $t(353) = 1.9$, $p = .058$), and no significant interaction (β = -.04, $t(352) = .57$, $p = .569$). Lastly, for the randomness subscale, there was also no significant main effect of Genetic Feedback (β = .03, $t(354) = .57$, $p = .569$) or Bart behavior (β = -.08, $t(353) = 1.48$, $p = .142$), and no significant interaction (β = -.03, $t(352) = .36$, $p = .717$).

4. DISCUSSION

Building on findings of earlier investigations on the effects of genetic feedback on behavioral outcomes, our first primary hypothesis was that people who were given genetic feedback indicating that they are genetically disposed to risky behavior would demonstrate higher risk-taking behavior than those who received feedback indicating that they are genetically disposed to risk aversion. This hypothesis was confirmed. Participants who received genetic feedback indicating that they were genetically predisposed to risky behavior demonstrated higher risk-taking behavior than those who received feedback indicating that they were genetically predisposed to risk aversion.

We also expected that an incongruence between behavior and genetic feedback would be associated with a greater perception of free-will. That is, for people relatively high in risk taking, those in the risk aversion gene condition would report higher free-will beliefs than those in the risk-taking gene condition. Reversely, for those low in risk taking behavior, those in the risk-taking gene condition would report higher free-will beliefs than those in the risk averse gene condition. However, this second hypothesis, that risk-taking behavior would interact with participants' genetic feedback condition to predict beliefs in free-will, did not generate support. The congruence between behavior and genetic feedback was not associated with a diminished perception of overall free-will amongst participants, nor was it associated with diminished scores on the free will subscales (scientific determinism, fatalistic determinism, and randomness).

4.1. The Effect of Genetic Feedback on Behavior

Our finding that people who were given genetic information indicating that they were genetically disposed to risky behavior demonstrated higher risk-taking behavior than those who received information indicating that they were genetically disposed to risk aversion fits with earlier investigations on the effects of genetic feedback on behavioral outcomes (e.g.; Bloss, et al., 2011; Lineweaver, et al., 2014; Turnwald et al., 2019). A potential reason why the effects of genetic etiology beliefs tend to extend to actual behavior is that they instill a set of expectations that guide people towards responses in line with those expectations, in a process similar to the placebo effect (Turnwald et al., 2019). While our study brings additional evidence in support of preexisting studies indicating that genetic beliefs can causally impact behavior, it also extends the extant literature in several different ways. First, to our knowledge, this is the first study to show that the effect of genetic beliefs on behavior is not limited to concrete, health-related outcomes, but can also impact more abstract and psychologically complex characteristics (i.e., risk-aversion). Although people's intuition might be that health-related outcomes (e.g., obesity) are more heritable or genetically based than psychologically complex outcomes like risk aversion, our results indicate that genetic feedback for a more psychologically complex characteristic can also alter behavior. In other words, even when people likely have a weaker expectation of heritability or genetic influence in their lay intuitions, the effect of genetic information on behavior still exists.

Secondly, our results also contribute to the existing literature by investigating the impact of genetic beliefs on behavior in relation to a less stigmatized variable. While previous studies have mainly investigated negatively-charged, health-related outcomes such as obesity (e.g., McVay, et al., 2016) or alcoholism (e.g., Dar-Nimrod, et al, 2013), we looked at risk-taking, which is a relatively neutral behavior that can be interpreted both positively and negatively depending on context. Thus, we can conclude that despite the fact that an arguably more neutral behavior such as risk-taking might not have the same consequences to one's self-perception, the effect of genetic information on behavior still exists.

In sum, our study provides further evidence that genetic information carries weight when it comes to its impact on behavior. According to previous research, this is most likely because exposure to genetically based arguments evokes essentialist biases that lead people to adopt essentialist views, or, in other words, to see facts or events as natural, immutable, discrete, and solely caused by genetic influence (Vess et al., 2018). Our study also extends the literature by showing that the impact of genetic feedback is not restricted to those outcomes about which people likely have pre-existing strong heritability or genetic etiology beliefs, or domains where there is already a strong genetic link to the outcome; even when the outcome of interest is less obviously connected to genes, the effect of genetic information on behavior can still be observed.

4.2. The Interactive Effect of Genetic Feedback and Behavior on Free-Will Beliefs

Since our second hypothesis, that risk-taking behavior would interact with participants' genetic feedback condition to predict beliefs in free-will, did not generate support, we can conclude that there is no interaction effect between general beliefs of free will and receiving genetic information. However, it is important to keep in mind that there are a couple alternative explanations for those findings. First, it is possible that general free-will beliefs are maintained, while specific free-will beliefs that are phenotype specific are altered. In other words, one might argue that participants were able to maintain a broad belief in free will, while still altering their free will beliefs about the specific behavior manipulated (risk taking). Since we only measured general free will beliefs, our data is mute regarding this possibility. Future studies should address this issue by including a free will measure specific to the task itself.

Second, it is also possible that the subjective experience of free-will was not altered because people were unaware of the effect of the genetic feedback. Previous work on apparent mental causation (Wagner & Wheatley, 1999) suggests that people can experience agency even when they do not actually have it. The real causes of human behavior seem to be unconscious, so it is “not surprising that behavior could often arise without the person having conscious insight into its causation” (Wagner, 1999, p. 490). To address this possibility, future studies could consider measuring people's perceptions of their ability to control their behavior or introducing a measure of perceived free will over the upcoming task.

4.3.Limitations and Future Directions

Several limitations to this study should be noted. First, our study design only included one measure of risk taking, the Automatic Balloon Analogue Risk Task (Pleskac, et al., 2008). Sequential risk-taking tasks, especially the BART, have been widely used and proven powerful and useful methods in studying and identifying real-world risk takers (Pleskac, et al., 2008). According to Pleskac’s et al. review (2008), the BART predicts real-world risk taking, such as smoking, illegal drug use, unprotected sex, and gambling, in a broad range of populations (e.g., Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Bornovalova, Gwadz, Kahler, Aklin, & Lejuez, 2008; Lejuez, Aklin, Bornovalova, & Mool chan, 2005; Lejuez, Simmons, Aklin, Daughters, & Dvir, 2004, as cited in Pleskac et al, 2008). However, future studies might benefit from a more comprehensive measurement of risk-taking, using a combination of risk propensity scales (e.g., Eysenck, Pearson, Easting, & Allsopp, 1985; Zuckerman, 1994, as cited in Pleskac et al, 2008), as well as additional sequential risk-taking tasks, such as the TCU Self-Rating Form (Knight, Holcom and Simpson, 1994) or the Domain-Specific Risk-Taking scale (Weber, Blais and Betz, 2002). Using additional measures would help establish more convergent support for this effect.

Future studies should also consider investigating temporal durations of the effect of genetic information on behavior. Specifically, an important question to answer that our study did not address is whether the observed effects of genetic feedback on behavior persist over time, or whether they tend to dissipate after a while. A potential way of tackling this issue is by adjusting the study design so that behavior could be measured subsequently. Another beneficial addition to our current design could be including a measure of free will beliefs that is less global, and more specific to the task itself. It is possible that while general and abstract free will beliefs are not impacted, more concrete perceptions of one’s free will related to the task at hand could be. Additionally, future studies could consider measuring perceptions of how well participants are able to control that specific behavior before they engage in the task.

5. SUMMARY AND CONCLUSIONS

In conclusion, our study provides additional evidence for the importance of genetic information, as well as hopefully encourage future studies to continue to pay attention to the psychological effects of genetic feedback. The exploration of the broader implications of genetic testing, in particular its potential consequences for behavioral expression, psychological well-being, and self-perceptions, is essential considering the increasing popularity of direct-to-consumer genetic testing. The general availability and accessibility of genetic information might lead to genetic essentialism being an increasingly frequent fallacy in the modern, post-scientific revolution world, which could prove problematic considering the numerous negative implications of genetic essentialism (e.g. Bastian & Haslam, 2006; Heine, et al., 2017; Keller, 2005; Kimel, et al., 2016). Additionally, if genetic essentialism is indeed related to disbelief in free will, which needs further investigation, we might also have to add the beneficial outcomes of free will (e.g., Alquist, et al., 2013; Feldman, et al., 2016; Kondratowicz-Nowak & Zawadzka, 2018; Li, et al., 2018; MacKenzie, et al., 2014;) to the list of the negative outcomes that come with an unfit increase in the availability of genetic information.

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APPENDIX

Table 1

Means and Standard Deviations on the Automatic Balloon Analogue Risk Task and Free-will and Determinism Scale

	N	*M*	*SD*
Risk-taking behavior	364	1828.55	458.03
Free will	370	3.62	.53
Scientific determinism	370	2.90	.52
Fatalistic determinism	370	2.67	.87
Randomness	370	3.40	.57