HHS Public Access

Author manuscript

J Nutr Educ Behav. Author manuscript; available in PMC 2024 January 01.

Published in final edited form as:

J Nutr Educ Behav. 2023 January ; 55(1): 55–67. doi:10.1016/j.jneb.2022.09.005.

Using Educational Videos and Perspective Taking to Communicate Gene-Environment Interaction Concepts about Eating Behavior: Effects on Empathy and Weight Stigma

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Abstract

Objective: This study investigated whether education about gene-environment interaction (G*E) concepts could improve G*E knowledge and have positive downstream effects on empathy and weight stigma.

Design: We conducted a randomized trial using a 2x2 between-subjects design.

Setting: Online.

Participants: 582 American participants from the Prolific platform.

Intervention(s): Participants were randomly assigned to watch either an educational video or a control video. Participants then watched a set of vignette scenarios that depicted what it is like to have a predisposition toward obesogenic eating behaviors, from either a first-person or third-person perspective.

Main Outcome Measure(s): Participants completed questionnaires measuring G*E knowledge, causal attributions, weight stigma, and empathy post-intervention.

Analysis: 2x2 between-subjects ANOVAs were conducted as well as exploratory mediation analyses.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

All data and syntax underlying these analyses are publicly available at the Open Science Foundation (https://osf.io/tajhq/?view_only=40570f9be4de46e4aa94276426f09b9b).

Results: Participants who watched the educational video demonstrated greater G*E knowledge, reported higher empathy towards the characters in the vignette scenarios, and held fewer stigmatizing attitudes (notably blame) towards individuals with higher weight. Exploratory mediation analyses indicated that the educational video led to these positive downstream effects via increasing the extent to which participants attributed genetic causes to eating behaviors.

Conclusions and Implications: Education about G*E causes of eating behaviors can have beneficial downstream effects on attitudes towards people with higher weight.

Keywords

weight stigma; blame; empathy; obesity; gene-environment interaction; perspective taking; eating behavior

INTRODUCTION

Weight stigma is pervasive in Western society. Discriminatory attitudes against people with higher weight have been observed at comparable rates to racial and gender discrimination[1] and are often more overt because weight stigma is viewed as a more socially acceptable form of negative bias.[2,3] Weight stigma involves a tendency to believe individuals are personally responsible for their weight. However, weight has a sizable genetic component, with twin studies estimating that genetic factors account for approximately 70% of the variance in body mass.[4] Communication about the role of genetics in weight may therefore help to alleviate weight stigma by reducing the extent to which individuals are blamed for their weight.

Importantly, however, genetic risk for obesity is accentuated by certain environments and diminished by others.[5] This change in magnitude of genetic risk by environment is known as a gene-environment interaction (G*E). An added complexity of G*E in the context of weight is that both genetic and environmental factors often affect weight indirectly via influencing behaviors, such as dietary intake.[6] Given the complexity of G*E concepts, it is not surprising that they are poorly understood by the general public.[7] If the public better understand the role genetics play in eating, they may be less likely to blame people for their higher weight, thus increasing empathy and reducing stigma.[8] However, creation and delivery of genetics education programming can be challenging. Individuals with lower health literacy and numeracy, for example, are less likely to understand genetic information presented in traditional printed formats.[9] Carefully designed and validated educational interventions using alternative communication approaches are therefore needed to improve the public's understanding of G*E influences on eating and related concepts.

G*E In Weight And Eating Behavior

The causal network of obesity is extremely complex. Researchers have identified more than 250 genetic loci associated with weight,[10] and at least as many environmental factors that can interact with genes to influence an individual's weight status. Specific environmental factors that moderate the heritability of obesity include prenatal exposures, calorific food availability, built environment, education status, smoking and alcohol use, socioeconomic status, deprivation, and stress.[5] Another influence on weight is eating behavior. Eating

behaviors themselves are also highly heritable.[11,12] Heritability estimates for disinhibition and uncontrolled eating, for example, range anywhere from 21-77%.[4,12,13] Genetic variants have been related to eating phenotypes such as higher consumption, snacking, binge-eating, eating in the absence of hunger, vegetable distaste, and higher fat and sweetness intake.[11,12] Eating behaviors are also governed by G*E mechanisms. Environmental factors such as learned habits, and access to healthy foods can augment or attenuate genetic influence on eating.[11] A person genetically predisposed to snacking when not hungry, for example, is more likely to eat such snacks in environments of plenty than of scarcity.

Secondary Effects Of Communicating About G*E

The secondary effects of educating the public about genetic and G*E influences on *weight* have been previously investigated in depth, including the influence of educational interventions on causal attributions[14,15,16] and weight stigma.[14, 15, 17-20] However, very little research has investigated the effects of communicating G*E causes of *eating behaviors*. We consider the potential secondary effects of communicating these concepts on participants' causal attributions, weight stigma, dietary self-efficacy and intentions, and empathic concern.

Causal attributions.—Although there is mounting evidence of G*E influences on weight and eating behaviors, the public generally does not acknowledge these variables as having a significant genetic component. Both British[21] and US[22] samples underestimate the importance of genetic influences on weight (people in the US, for example, estimate a genetic contribution of 42%, compared to an actual heritability of 63%),[22]. The public are even less accepting of the notion that eating behaviors are highly influenced by genetics.[23,24] Previous attempts to communicate with the public about G*E in the context of *weight* have found mixed results. For example, participants who receive G*E messages about weight generally endorse genetic causes of obesity more often than control groups given no information about the etiology of weight[14] or given environmental explanations of weight.[15] However, in some cases, G*E education materials about weight have lowered endorsement of genetic causes of obesity compared to controls, notably for parents of a child with higher weight.[16] In contrast to weight-related research, there is no known research to date on how educational interventions on G*E causes of *eating behaviors* alter causal attributions for eating behaviors and/or weight.

Weight stigma.—If G*E education leads individuals to change their causal attributions, it may also have influences on weight stigma. Solely genetic explanations for weight have, in some cases, been shown to reduce implicit anti-fat attitudes and increase explicit pro-fat attitudes compared to behavioral explanations.[19, 20] This is because weight stigma involves beliefs that people of higher weight status are to blame for their condition.[25, 26] The efficacy of genetics-based weight stigma interventions may therefore depend on the extent to which these interventions shift beliefs about the causes of weight. G*E-based interventions may have similar effects by demonstrating how environments impact people's weight unequally depending on their genes, such that individuals with higher weight may not be seen as blameworthy. However, unlike genetic information alone, G*E also indicates that obesity is modifiable because environmental factors can be leveraged as part of a weight management

strategy. This perceived modifiability may also impact weight stigma. Although believing a particular stigmatized attribute can be modified generally increases blame and perceived responsibility, recent research indicates that believing obesity is modifiable can also reduce stigma by increasing beliefs that higher weight can be offset and thus is not an inherent attribute.[27] To date, specific research on the effects of G*E education about weight has found mixed results on weight stigma. Some researchers have found a reduction in weight stigma,[16] and others find no impact.[15, 17, 18] Again, no research to date has determined if G*E messages about *eating behaviors* can reduce weight stigma.

Empathic concern.—G*E education about eating behaviors may help individuals empathize with people who experience food differently from themselves. Following the same mechanism outlined above, G*E education may help individuals acknowledge the sizable genetic component in eating behaviors, which in turn may help them to understand the challenges faced by people with genetic predispositions that make obesogenic eating more likely. In other words, if G*E explanations demonstrate that environments impact people's weight unequally depending on their genes, people may feel more empathic concern for those who find themselves to be struggling due to their unique genetic and environmental circumstances.

In addition to improving understanding of G*E concepts to increase empathic concern, another mechanism to arouse empathy is perspective-taking. Perspective-taking involves "actively imagining the world from another's vantage point" [28] and is reliably associated with higher levels of empathic concern [29, 30] and reduced negative bias.[31] Previous research has found that people who generally engage in more perspective-taking are less likely to endorse negative stereotypes and more likely to endorse positive stereotypes of people with higher weight.[32] Moreover, research that has asked people to take the perspective of characters with higher weight has successfully increased empathy and reduced weight stigma.[33] However, the way one engages in perspective-taking may matter. Empathy researchers differentiate between imagine-self perspective-taking and imagine-other perspective-taking.[29] Imagine-self perspective-taking involves imagining how you would feel if you were the one in another person's situation, whereas imagine-other perspective-taking involves imagining how someone else feels in their situation. A first-person story, i.e., using "I" pronouns and experienced from the main character's point-of-view, is likely to elicit imagine-self perspective-taking, whereas a third-person story would be more likely to induce imagine-other perspective-taking. This is because first-person stories tend to lead to higher feelings of embodiment and transportation into the narrative than third-person stories[34,35] and so are likely to prompt people to reflect on how they themselves would feel in this situation.

There are two reasons to suspect that a first-person perspective may yield more beneficial effects on G*E comprehension and weight-related attitudes than a third-person perspective. First, when describing statistical concepts such as G*E, engaging emotional arousal in first-person perspective may act as an attentional cue for self-relevance, which may also serve to improve comprehension of the material.[36] Second, although both types of perspective-taking increase empathic concern, only imagine-self perspective-taking also increases perceived levels of similarity between the participant and the target. Perceived similarity has been

theorized to be an additional route to prosocial behaviors beyond the effect of empathic concern.[37]

Dietary self-efficacy and intentions.—If individuals understand the G*E forces shaping their eating behaviors and weight, they may gain self-efficacy about controlling these forces in the future. Studies examining this possibility have generally resulted in null effects in the context of weight.[18] Despite these null results, G*E education may have benefits over genetics-only education strategies, which are shown to negatively impact food choices.[24] Given the complexity of G*E and the mixed character of the existing literature, it is likely that the nature of these outcomes depends on how the concept is communicated. One potential strategy is to present concrete examples of G*E influences on eating behaviors. These examples would allow individuals to visualize themselves encountering similar challenges and imagining how they might overcome them. In line with classic social cognition research, the act of imagining successful resolutions can make those events seem more likely and serve to bring them about.[38] Specifically, mentally rehearsing hypothetical scenarios can increase people's motivation and expectations of success and can prompt them to make concrete plans.[39]

The Current Study

We designed and created a short educational video about G*E influences on eating behaviors and two vignette scenarios to exemplify these concepts. An online randomized trial was conducted to evaluate these education materials on people's G*E knowledge and determine their secondary effects on participants' attitudes towards people with higher weight. We pre-registered our hypotheses and analysis plan with Open Science Foundation (OSF) prior to data collection (https://osf.io/6n57g/?view_only=ceae83a7f7c3441aa089f9ed3419105b).

We hypothesized that 1) Education materials would result in better comprehension of G*E concepts than control materials; 2) Education materials would result in greater attitude change (higher empathy and lower weight stigma) than control materials; 3) First-person perspective vignettes would result in greater attitude change than third-person perspective vignettes; 4) A significant interaction would emerge between education materials and vignette perspective on attitude change such that the impact of seeing the first-person perspective compared to a third-person perspective would depend upon whether participants saw the educational materials or control materials first. We also explored whether the effects of education materials on attitudes were mediated by changes in causal attributions but did not pre-register this hypothesis. Furthermore, we report results from two exploratory attitude outcome measures: dietary self-efficacy and behavior change intentions.

METHODS

We evaluated the efficacy of the educational video and its accompanying vignettes using a 2x2 between-subjects design. Participants were randomly assigned to watch either the G*E education video or a control video. Participants then watched a set of two vignette scenarios, randomized in first-person or third-person perspective, that described what it is like to have a predisposition towards obesogenic eating behaviors. Finally, participants completed knowledge checks and a battery of empathy and weight-stigma questionnaires. This study

was ruled exempt by the Office of Human Subjects Research Protection of the National Human Genome Research Institute and signed consent was not required (#P204913). The study was performed in accordance with the Declaration of Helsinki.

Participants

Participants were recruited via the online platform Prolific (https://prolific.co/). To determine the sample size, we conducted an a priori power analysis for a fixed effects omnibus ANOVA with an alpha of .05 and power of .80 for a 2*2 design. In this analysis, we used a conservative effect size associated with between-group differences in the assessment of digital learning materials wherein Cohen's $f = .12$.[40] Based on this effect size, we had a target N of 547. We oversampled to ensure a sufficient sample following data exclusions. Participants were excluded if they indicated they could not see or hear the video, did not complete the survey, did not pass attention checks, did not indicate they would answer truthfully from their own knowledge or indicated that their data should be excluded for any reason. Following these criteria, a total of 76 participants were excluded. Our final sample ($N = 582$) consisted of 253 men, 316 women, and 13 individuals of other genders. Gender was self-reported from a list including man, woman, genderqueer and/or nonbinary, or other (please specify). Please see Table 1 for additional sample demographics.

Materials

G*E education materials.—Participants assigned to receive education on G*E concepts watched a 5-minute video created by the research team explaining these concepts with simple graphic animations and narrative voiceover. The educational video first explains what genes are and provides examples of their impact on physical characteristics and a variety of tastes and preferences. The video then goes on to explain how a person's environment can interact with their genetics to influence eating behaviors. Copies of all the video materials are available online via OSF (https://osf.io/tajhq/?view_only=40570f9be4de46e4aa94276426f09b9b).

Control education materials.—Participants assigned to the control condition watched a 5-minute video about spicy food with similar simple graphic animations and a narrative voice-over. This video was created by the research team.

Vignette scenarios.—Participants watched two vignette scenarios that were designed for the purposes of this study. Each scenario had still storyboard sketches with a narrative voiceover (see Figures 1 and 2). Participants either watched these videos from a first- or third-person perspective. The first-person vignettes displayed the events through subjective shots that showed what the main character was viewing. The voiceover described the main character in second-person language (e.g., "you"). Note that although the language was second-person, the visual perspective was first-person so we will refer to this as the first-person perspective. The third-person vignettes described the main character as "she" or "he" and the storyboard displayed the entire scene as if from the viewpoint of an unseen observer. Extensive informal piloting of these vignettes was conducted to ensure they were relatable and understandable to lay audiences.

In the first scenario (diner guest scenario), participants were exposed to a food choice situation from the perspective of a person with a genetic predisposition to strongly dislike bitter foods. The vignette character attends a dinner party where the only non-calorie-dense food choices are bitter green vegetables (i.e., brussels sprouts, kale). Their friends encourage them to try the green vegetables and they reluctantly do, despite an overwhelming repulsion. They then move to eat more appealing, calorie-dense foods (i.e., fried chicken, macaroni & cheese).

The second scenario (office worker scenario) was designed to illustrate the perspective of an individual with a genetic predisposition to be highly attentive to palatable food cues in the environment. The vignette character is doing a repetitive file sorting task when a coworker appears with a plate of chocolate chip cookies, which they leave in front of the character. The vignette character becomes frustrated with the file sorting task as the cookies become increasingly distracting and the character eventually eats the cookies.

Measures

Genetics knowledge[1].—General G*E understanding and literacy was measured with a 9-item subscale of the Public Understanding and Attitudes towards Genetics and Genomics (PUGGS) questionnaire “Gene-environment interaction” subscale.[41] Participants were given 1 point for each correct answer. Incorrect and “don’t know” answers were both considered incorrect ($\alpha = 0.74$). Specific G*E knowledge about weight and eating behaviors was measured using a questionnaire that was designed by the study team. Some questions could be answered by simply remembering information found in the educational materials, other questions required higher level learning such as application and generalization of knowledge. Participants answered 15 true-false questions with a focus on weight and eating behaviors. Example items included “Genes affect which flavors of food people enjoy” and “Some lifestyle choices affect people differently because they have different genes”. Participants were given 1 point for each correct answer. Incorrect and “don’t know” answers were both considered incorrect ($\alpha = 0.73$). See Figure 3 for items.

Genetic causal attributions.—Two items were used to assess participants’ endorsement of genetic causes of obesity and eating behaviors adapted from previous research.[21] Participants were presented with two 0-100 scales and were asked, “What percentage of someone’s [obesity risk/eating behavior] is caused by genetics?”.

Weight stigma.—Stigma towards people with obesity was measured using the Anti-Fat Attitudes scale which asks people to indicate how strongly they agree with 13 statements from 1 = Strongly Disagree to 5 = Strongly Agree.[42] Participant’s dislike of people with higher weight was measured with the Dislike subscale which includes 7 items such as “I really don’t like fat people much” ($\alpha = 0.88$). Participants’ fear of becoming overweight themselves was measured with the Fear subscale which contains three items such as “I worry about becoming fat” ($\alpha = 0.82$). Participants’ tendency to blame people of higher

[1]We pre-registered the use of an open-ended knowledge check that asked participants to apply what they had learned about gene-environment interaction concepts to a novel eating behavior. However, participants' responses were of poor quality and difficult to interpret. Therefore, we do not report the data here.

weight for their weight status was measured with the Willpower subscale which includes three items such as “Fat people tend to be fat pretty much through their own fault” (α = 0.71).

Dietary self-efficacy and intentions.—A single item was used to measure participants’ confidence to control their diet: “How confident are you in your ability to control your diet?”. Participants responded on a scale from 1 = Not at all to 5 = Extremely. Dietary self-efficacy was assessed using five items from the Self-Efficacy and Eating Habits Survey,[43] specifically the subscales related to the ability to stick to a diet and to reduce calories. Items included “When I feel hungry, I will be able to choose healthy food over less-healthy options”. Participants responded on a 5-point scale from 1 = Strongly Disagree to 5 = Strongly Agree (α = 0.90). Dietary intentions were assessed using two items previously used to measure dietary intentions[44]: “How likely is it that you will try to change your diet in the next 6 months?” and “I intend to make changes to my diet in the next 6 months”. Participants responded on a 5-point scale from 1 = Not at all to 5 = Extremely (α = 0.94).

Empathic concern.—Participants were asked to what extent they were feeling six empathic emotions (tender, softhearted, warm, sympathetic, compassionate, moved) towards the [office worker/dinner guest] from 1 = None at all to 5 = Extremely.[45] Ratings toward the two vignette characters were combined (α = 0.93). Using the same six empathic adjectives, participants were asked to rate how they felt towards people with obesity in general (α = 0.95).

Manipulation check.—Participants were asked “Was the [dinner party/office worker] scenario described from a second-person perspective (i.e., "you") or a third-person perspective (i.e., "he/she")”? Participants also had an option to indicate they were unsure.

Data Analysis

2x2 between-subjects ANOVAs were conducted to investigate the main effects of education materials and vignette perspectives on all knowledge and attitude measures as well as to investigate any interaction between these variables. Exploratory mediation analyses used the Hayes procedure.[46] The data and syntax underlying these analyses are available via OSF (https://osf.io/tajhq/?view_only=40570f9be4de46e4aa94276426f09b9b).

RESULTS

Impact of Education Materials And Perspective-Taking

Genetics knowledge.—Participants’ genetics knowledge was significantly higher after watching the educational video compared to watching the control video. There was a significant main effect of the educational materials for the knowledge check ($F(1,578) = 157.72$, $p < .001$, see Figure 3), and the PUGGS questionnaire ($F(1,578) = 13.67$, $p < .001$). There was no main effect of vignette perspective on either measure of genetics knowledge ($ps > .05$) and no interaction between education materials and vignette perspective ($ps > .05$). See Table 2 for all means and standard deviations.

Causal attributions.—Participants were more likely to endorse genetic causes of obesity ($F(1,578) = 9.23$, $p = .002$) and eating behaviors ($F(1,577) = 28.30$, $p < .001$) after watching the educational video compared to the control video. There was no main effect of vignette perspective on causal beliefs (ps >.05) and no interaction between education materials and vignette perspective (ps >.05). See Table 2 for all means and standard deviations.

Weight stigma.—Participants reported significantly less blame towards people with higher weight after watching the educational videos compared to the control videos as measured by the Willpower subscale (Willpower subscale, $F(1,578)= 9.92$, $p = .002$). Anti-fat attitudes on the Fear and Dislike subscales were not significantly different between conditions (ps >.05). There was no main effect of vignette perspective on any anti-fat attitude subscale (ps >.05) and no interaction between education materials and vignette perspective (ps >.05). See Table 2 for all means and standard deviations.

Dietary self-efficacy and intentions.—Participants' confidence and self-efficacy regarding their ability to change their diet were not influenced by education materials, vignette perspective, or their interaction (all ps >.05, see Table 2). Participants' intentions to change their diet in the next 6 months were also not influenced by education materials, vignette perspective, or their interaction (all ps >.05, see Table 2).

Empathic concern.—Participants' empathy towards the main characters in the vignettes was significantly higher after watching the educational video compared to watching the control video ($F(1,578)= 4.27$, $p = .039$, see Table 2). There was no main effect of vignette perspective on empathy towards the main characters (ps >.05) and no interaction between education materials and vignette perspective (ps >.05). Participants' empathy towards people with obesity was not different between conditions. Participants reported similarly high levels of empathy towards people with obesity regardless of condition ($F(1,578)= 0.00$, $p = .924$, see Table 2). There was no main effect of vignette perspective on empathy towards people with obesity (ps >.05) and no interaction between education materials and vignette perspective (ps >.05).

Mediation Analyses

We used the Hayes (2013) procedure to investigate whether the educational video led to higher empathy and lower stigmatizing blame via increasing the extent to which participants attributed genetic causes to eating behaviors (see Figure 4). We confirmed that genetic attributions significantly mediated the effect of education on empathy and stigmatizing blame[2]. Specifically, a significant indirect effect of education was found for empathy ($b = 0.16$, 95% CI [0.09, 0.23]) and blame ($b = -0.09$, 95% CI [−0.16, −0.03]). The direct effect of education was rendered non-significant for empathy, indicating that genetic attributions fully mediated this relationship ($b= -0.16$, $p = .065$) whereas the direct effect on blame remained significant, indicating that genetic attributions partially mediated this relationship ($b = -0.14$, $p = .037$).

[2]Genetic attributions for obesity also fully mediated these relationships ($b_{empathy} = 0.11$, 95% CI [0.04, 0.18]; $b_{stigma} = -0.05$, 95% CI [−0.08, −0.02]). Genetic attributions for obesity and genetic attributions for eating behavior were highly correlated ($r = 0.84$, $p < .001$), so we focus here on eating behaviors.

We also conducted exploratory mediation analyses to determine whether the educational video had a positive effect on blame via increasing empathy towards people with obesity. Our data were not consistent with this interpretation; the direct effect of education remained ($b = -0.237$, $p < .001$) and there was no significant indirect effect via empathy ($b = 0.003$, 95% CI [−0.05, 0.05]).

Manipulation Efficacy

Participants viewed both vignette scenarios in either first-person or third-person perspective. Yet not all participants correctly reported which perspective they had watched, indicating that the manipulation may have been too subtle, particularly in the first-person condition. For the dinner party scenario, only 69% of participants in the first-person perspective correctly identified their condition while 90% of participants in the third-person condition did. Following the same pattern, for the office worker scenario, only 64% correctly identified the first-person perspective, while 95% correctly identified the third-person perspective.

Sensitivity analyses.—To establish whether there was a significant effect of perspective within only those participants who correctly identified their condition, we re-ran the pre-registered analyses with this smaller sample ($N = 420$, $N_{first} = 160$, $N_{third} = 260$). Regardless, there were still no significant effects of perspective on any outcome measures and no significant interactions between perspective and education materials (all ps >.05).

DISCUSSION

Overall, the educational video about G*E influences on eating behaviors led to a better understanding of G*E concepts compared to controls and had some positive secondary effects on attitudes including empathy and weight stigma. However, we found that participants' attitudes were not influenced by whether they watched the vignette scenarios in first- or third-person perspective, and perspective did not moderate the efficacy of the education materials. Exploratory analyses suggest that secondary effects of G*E education were due to higher genetic causal attributions for eating behavior.

Participants who watched the education materials had a better comprehension of G*E concepts in general and understood their relevance to obesity and eating behaviors. We provide preliminary support for using video-based materials to successfully communicate the importance of G*E for eating behaviors, although further evidence is needed to ensure the public can apply this knowledge to improve their own diet and health.

Education about G*E influences on eating behaviors also appears to have some beneficial secondary effects on reducing blame and increasing empathy. These attitude changes appear to result from heightened genetic causal attributions among those who received the educational videos. In line with previous research demonstrating that solely genetic explanations can reduce implicit anti-fat attitudes,[19,20] G*E education may have successfully convinced participants that people are not solely to blame for their weight. G*E education materials also led to heightened empathy towards the vignette main characters, but notably, these increased empathic feelings did not extend to people with obesity in general.

G*E explanations indicate that obesity is, in part, controllable because environmental factors can be used to modify one's weight status. Thus, unlike presenting solely genetic explanations for obesity, G*E education has the potential to reduce stigma without undercutting dietary self-efficacy and motivation. In this study, participants who received the G*E education materials had similar dietary self-efficacy and confidence compared to controls, in line with previous research on G*E education[18,24] and in contrast to previous research on genetics only education which has been shown to reduce dietary self-efficacy.[24] Although the absence of a backfire effect indicates G*E education is likely preferable to genetics-only education, further research is needed to establish how to improve dietary self-efficacy and confidence while still communicating accurate information about the etiology and mechanisms behind obesity. One potential strategy is explicitly demonstrating how environmental changes can moderate genetic influences on eating (such as providing a concrete example of how to modify one's environment by making alternative food choices available). Vignette examples could similarly be used to allow people to compare and contrast the impact of genetics in different environments.

In contrast to our expectations, we found no effect of viewer perspective and no interaction with perspective on any of our outcome variables. A potential explanation for this null result is that participants did not distinguish between the two conditions – a pattern that was suggested by our manipulation check. In particular, participants in the first-person condition did not appear to recognize it as such. One reason our perspective-taking manipulation may have failed is that the language or storyboard imagery may have been too subtle or unclear. However, conscious memory of the manipulation might not be necessary for effects to be observed, and sensitivity analyses did not yield an effect of perspective even among participants who passed the manipulation check, suggesting that there are other reasons perspective was not influential.

Although unexpected, this result is not unprecedented. Several other studies have observed null effects when asking participants to engage in self- versus other-perspective taking.[28, 47-50] Such null effects may be especially likely when participants have very limited information about the target whose perspective they are asked to adopt.[52] Future research should ensure that participants have sufficient knowledge about the vignette characters to engage in perspective-taking. Moreover, it is possible that participants' feeling of "matching" the avatars' characteristics may have influenced our results in unknown ways.[52]

Participants may have also struggled to engage in perspective-taking because of a lack of knowledge about the lived experience of the vignette characters. It may be difficult for people to imagine the sensorial and psychological aspects of a genetic predisposition toward obesogenic eating. Previous research has found that people are not very good at such imagination in general, but that experience with the situation can improve matters.[53] For genetic predispositions towards obesogenic eating, some participants may not have had related experiences in their own lives, making relying on imagination alone possibly ineffective. Researchers have attempted to solve this issue in other domains by using physical props (such as visually distorting eyeglasses, wheelchairs, etc.) to simulate various sensory experiences such as partial-sightedness and physical disability.[54] In recent years,

virtual reality has also become popular and has been used to some success to simulate bodily experiences such as a different height[55] or weight.[56] As such, virtual reality may have particular utility in simulating experiences that participants have not experienced themselves.[57]

In addition to the limitations regarding our perspective-taking manipulation discussed above, there are several other factors that should be taken into consideration when interpreting our results. First, although we found a significant impact of education materials on attitudes towards people with obesity, the size of these effects was small. Whether these small shifts in attitudes translate into more prosocial treatment of people with obesity remains to be seen. Indeed, it remains unlikely that any single intervention can lead to sustained improvements in attitudes. Nevertheless, our success may indicate a potential mechanism for reducing blame and increasing empathy – namely, enhancing people's comprehension of the G*E causes of obesogenic eating – which can be adapted into more long-lasting interventions.

Second, our sample was more educated (49.7% with a Bachelor's degree vs. 32.9%) and more White (91.4% vs. 75.8%) than the general US population, [59] which limits its representativeness and generalizability. It is particularly important not to generalize these results outside of the US, as anti-fat attitudes differ across cultures.[25]

Third, our vignettes presented dinner party and office work scenarios that, despite likely being common experiences for many Americans before the COVID-19 pandemic, were at the time of data collection subject to various levels of restrictions. How this disconnect influenced participants' ability to take the perspective of the vignette character is unknown.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Communicating G*E causes of eating behaviors to the public appears to be a useful way to improve attitudes towards people with higher weight. Therefore, we envision the potential for similar G*E education to be broadly disseminated as part of public health campaigns. Moreover, a greater understanding of these concepts may help improve patient-provider interactions around healthy eating and weight. Clinical encounters in which genetic influences on weight are discussed have been associated with both a reduction in patients' perceived weight-based stigma,[44,60] as well as less enacted bias on the part of the provider.[19] Similarly, a focus on G*E causes of eating may help to tackle entrenched weight stigma among the general public and healthcare providers.

Our research expands previous attempts to communicate G*E influences on *weight* by communicating G*E influences on *eating behaviors*. Compared to weight, the public is generally less accepting that eating behaviors have a genetic cause;[23, 61] therefore, beliefs about eating behaviors may provide a greater opportunity for educational intervention. This research provides initial evidence of this utility, and future educational interventions may benefit from focusing on eating behaviors specifically when attempting to improve attitudes towards people with higher weight.

ACKNOWLEDGEMENTS

This research was funded by the Intramural Research Program of the National Human Genome Research Institute.

SP and CF conceptualized the project. SP, AJM, ES, ST, CF, AD, and SC were involved in designing the study. SP, AJM, ES, ST, CF, and AD were involved in data collection. AJM and SP conducted data curation and formal analysis. All authors contributed to the drafting of the manuscript. SP provided project management and supervision. All authors have approved the final article.

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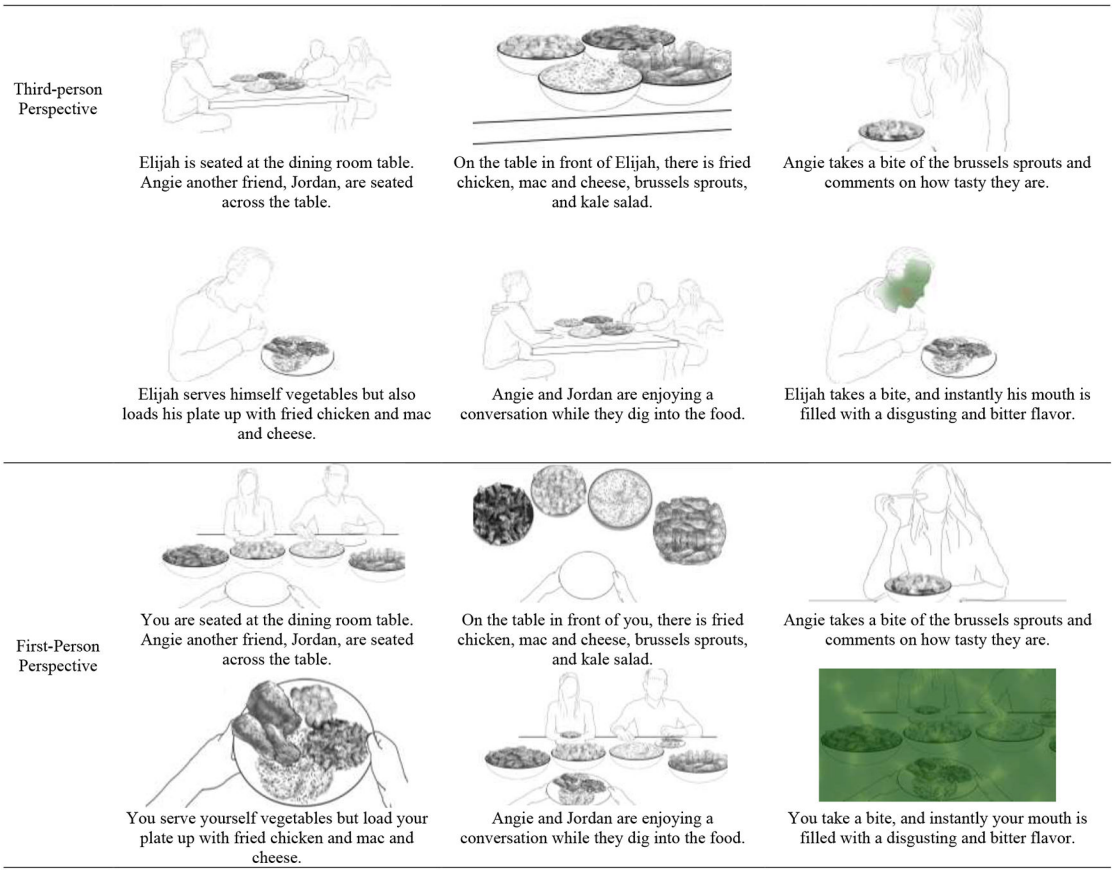

Figure 1.
Summary of Vignette Elements for Dinner Party Scenario

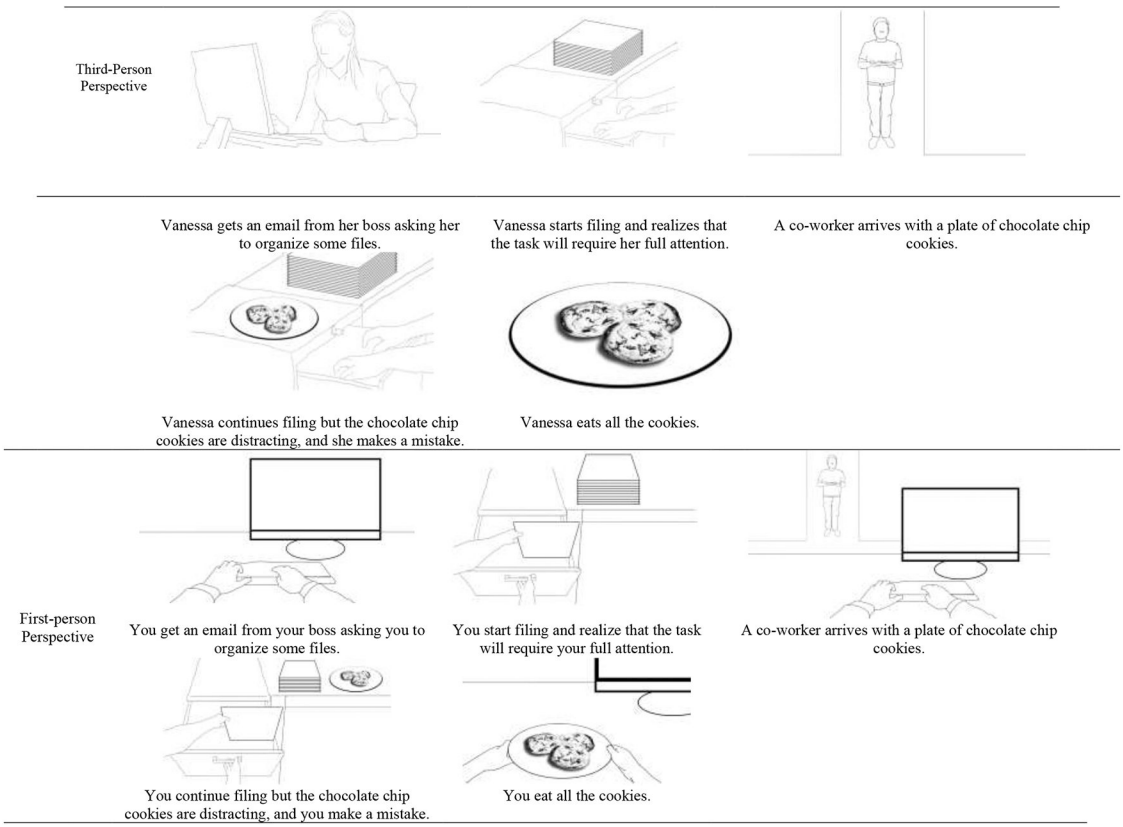

Figure 2.
Summary of Vignette Elements for Dinner Party Scenario

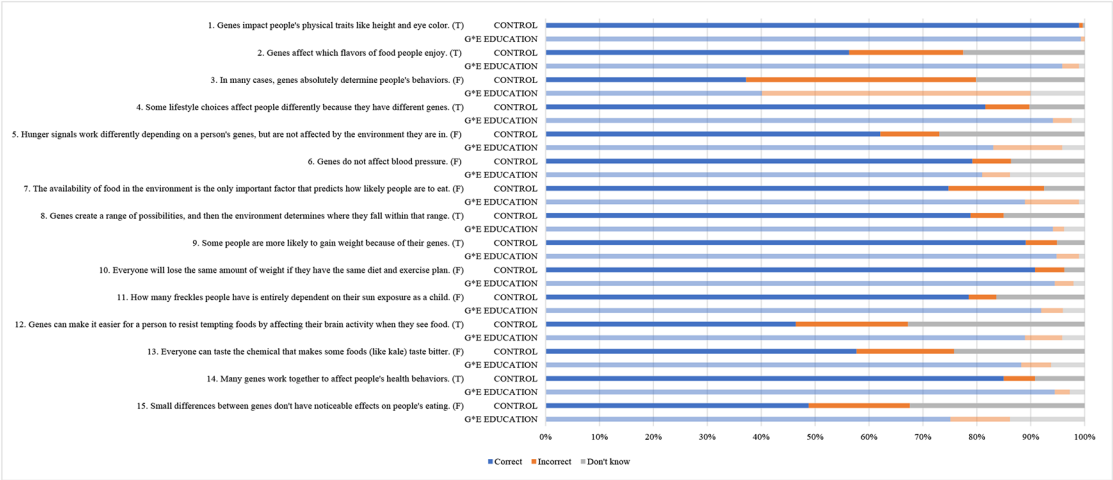

Figure 3.

Percentage of correct, incorrect, and don’t know responses to Knowledge Check Questionnaire by Education condition.

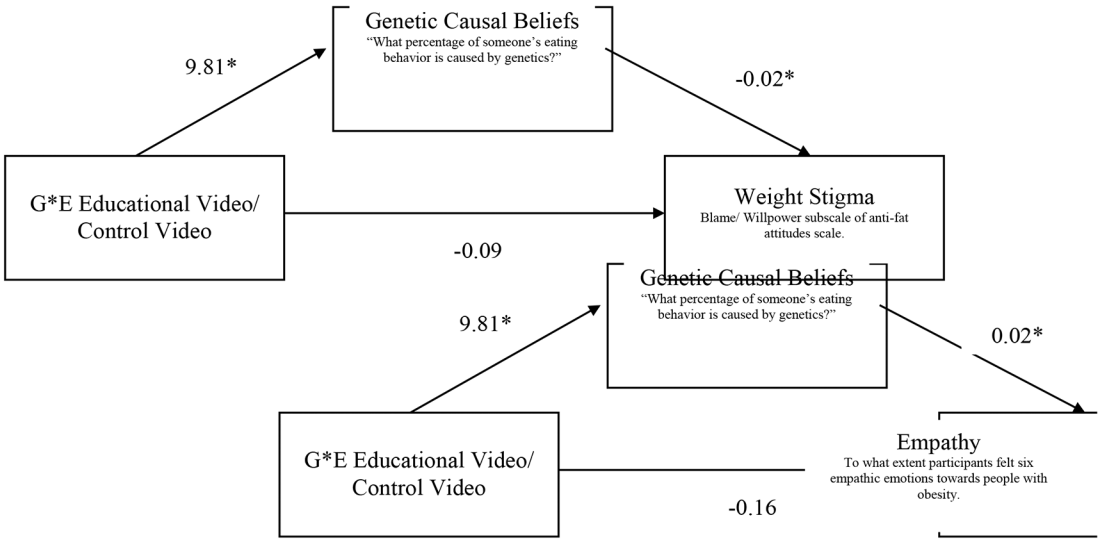

Figure 4.

Unstandardized regression coefficients for the relationship between condition and [weight stigma/empathy] as mediated by genetic causal beliefs. *$p < .001$.

Table 1.

Demographic Characteristics of Participants.

	N	Percent	Mean	SD
Age	582		34.1	11.5
BMI	582		27.2	7.6
Gender				
Man	253	43.5		
Woman	316	54.3		
Genderqueer, nonbinary, or ‘other’	13	2.2		
Race				
Asian	64	11.0		
Black	51	8.8		
First Nations/Native American	5	0.9		
White	424	72.9		
More than one race reported	27	4.7		
‘other’ reported	11	1.9		
Self-reported weight status				
“Very Overweight”	82	14.1		
“Overweight”	211	36.3		
“Just About Right”	251	43.1		
“Underweight”	36	6.2		
“Very Underweight”	2	0.3		
Employment status				
Full-time	245	42.1		
Part-time	106	18.2		
Student	81	13.9		
Caretaker/Parent	44	7.6		
Self-employed, unemployed, retired, ‘other’	106	18.2		
Marital status				
Married	199	34.2		
Never been married	298	51.2		
Widowed/Divorced/Separated	44	7.5		
Member of an unmarried couple	41	7.0		
Highest Formal Education				
Elementary school	1	0.2		
Some high school	10	1.7		
High school	77	13.2		
Some college	205	35.2		
College graduate	200	34.4		
Postgraduate	89	15.3		
Parent Status				
Yes, I am a parent	191	32.8		

	N	Percent	Mean	SD
No, I am not a parent	391	67.2		

Notes: Demographics were self-reported from a list of response options. Response options are indicated in the table above. Some responses add up to greater than 100% due to rounding.

Table 2.

Means (and standard deviations) for all pre-registered dependent measures by condition. Comparisons across conditions are reported for each measure.

	Educational Video		Control Video		Main Effect Education		Main Effect Perspective		Interaction	
	1st person	3rd person	1st Person	3rd Person	*F*	*p*	*F*	*p*	*F*	*p*
Genetics Knowledge										
General G*E Knowledge (max range 0-9)	6.14 (1.98)	6.37 (2.12)	5.56 (2.45)	5.56 (2.42)	13.67	<.001	0.40	.525	0.37	.540
Specific G*E Knowledge (max range 0-15)	12.85 (2.09)	13.31 (1.58)	10.81 (2.83)	10.51 (2.59)	157.72	<.001	0.15	.694	3.79	.052
Genetic Causal Attributions										
Obesity (max range 0-100)	45.43 (23.21)	47.30 (20.52)	40.70 (20.63)	41.00 (22.48)	9.23	.002	0.36	.551	0.19	.665
Eating Behaviors (max range 0-100)	43.37 (23.66)	46.17 (22.39)	34.96 (20.93)	34.90 (21.83)	28.30	<.001	0.54	.464	0.60	.438
Weight Stigma										
Anti-fat attitudes total (max range 1-5)	2.47 (0.73)	2.43 (0.62)	2.58 (0.64)	2.56 (0.67)	4.68	.031	0.31	.580	0.01	.927
Dislike subscale (max range 1-5)	1.93 (0.86)	1.78 (0.77)	1.93 (0.83)	1.92 (0.79)	1.04	.307	1.38	.240	0.98	.322
Fear subscale (max range 1-5)	3.08 (1.24)	3.29 (1.19)	3.34 (1.08)	3.29 (1.19)	1.60	.207	0.47	.494	2.21	.138
Willpower subscale (max range 1-5)	3.12 (0.98)	3.10 (0.89)	3.35 (0.83)	3.34 (0.88)	9.92	.002	0.04	.851	0.02	.887
Dietary Self-efficacy and Intentions										
Confidence to Control Diet (max range 1-5)	3.34 (1.05)	3.23 (1.00)	3.24 (1.06)	3.18 (1.14)	0.80	.371	0.93	.336	0.08	.774
Dietary Self-efficacy (max range 1-5)	3.60 (0.98)	3.46 (0.92)	3.50 (0.90)	3.53 (1.06)	0.03	.861	0.43	.510	1.25	.264
Diet Intentions (max range 1-5)	2.90 (1.28)	2.95 (1.29)	3.06 (1.26)	3.14 (1.34)	2.67	.103	0.34	.560	0.03	.871
Empathic Concern										
Empathy for vignette characters (max range 1-5)	2.51 (1.11)	2.62 (0.99)	2.35 (1.00)	2.42 (1.01)	4.27	.039	1.15	.284	0.04	.835
Empathy for people with obesity (max range 1-5)	2.73 (1.13)	2.91 (1.05)	2.83 (1.07)	2.82 (1.12)	0.00	.924	0.91	.342	1.11	.292

Results of 2*2 ANOVAs are reported for each measure. Alpha level 0.05.