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Cumulative Risk on the Oxytocin Receptor Gene (*OXTR*) Predicts Empathic Communication by Physician Assistant Students

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ABSTRACT
In the relationship between patients and health care providers, few communicative features are as significant as the providers' ability to express empathy. A robust empirical literature describes the importance of physician communication skills—particularly those that convey empathy—yet few studies have examined empathic communication by physician assistants, who provide primary care for an increasing number of Americans. The present study examines the empathic communication of physician assistant students in interactions with standardized patients. Over a 6-month period, each student conducted three clinical interviews, each of which was evaluated for empathic communication by the patients, the students' clinical instructors, and third-party observers. Students also provided saliva samples for genotyping six single-nucleotide polymorphisms on the oxytocin receptor gene (*OXTR*) that are linked empirically to empathic behavior. Consistent with recent research, this study adopted a cumulative risk approach wherein students were scored for their number of risky alleles on the single-nucleotide polymorphisms. Results indicated that cumulative risk on *OXTR* receptor gene predicted lower patient empathy scores as rated by instructors and observers, but not by standardized patients.

In the relationship between patients and health care providers, few interpersonal features are as significant as the providers' ability to express empathy. Empathic communication behaviors (both verbal and nonverbal) signify a provider's aptitude at understanding patients' experiences and seeing their conditions from their perspectives. That skill not only supports accurate information processing and diagnosis on the part of the provider; it also reassures patients, increasing their satisfaction with the encounter and their compliance with a provider's prescribed treatment regimen, while decreasing their likelihood of claiming medical malpractice (see Hojat, 2016).

Empathy is consequential in many provider–patient relationships, but perhaps particularly in the context of primary care. A robust literature has illuminated the effects of empathic communication from physicians (see Roter & Hall, 2006), whereas an increasing number of patients instead receive primary care from physician assistants. Few studies have examined perceptions of empathic communication by physician assistants, and none has addressed the genetic antecedents of empathic communication in physicians, physician assistants, or students training for those professions.

This article proposes that significant proportions of the variance in empathic communication ability may be explained by variation in communicators' genetic characteristics. We begin this literature review by describing the scope and practice of physician assistants, noting their increasing role in primary care. Next, we review extant research on empathy and its effects conducted with medical doctors/students and physician assistants/students. We then describe research on the genetic origins of empathic behavior, and finally, we present the study's hypotheses and research questions.

The physician assistant: Role and scope of practice

A physician assistant (PA) is a nationally certified and state-licensed health care provider who practices medicine on health care teams with physicians. PAs are trained in accredited master's-level programs and have prescriptive authority in all 50 U.S. states and the District of Columbia (American Academy of Physician Assistants, 2014).

A substantial number of PAs are engaged in primary care. According to the U.S. Department of Health and Human Services (DHHS) Agency for Healthcare Research and Quality, 43.4% of practicing PAs worked in primary care in 2010 (U.S. DHHS, 2010). The previous decade also saw a 50% increase in the number of hospital outpatient visits overseen by a PA or a nurse practitioner (NP; Hing & Uddin, 2011). Patients are therefore increasingly likely to see a PA, rather than (or in addition to) a physician, when seeking primary care (see Hooker, Cipher, & Sekscenski, 2005). Consequently, the communication skills of PAs in the clinical interview setting are an important focus of inquiry. Because physicians' communication skills have numerous associations with patient outcomes such as satisfaction and compliance with prescribed treatments (Hojat, 2016), the same is likely to be true for PAs' communication skills, particularly in the primary care setting (Hojat et al., 2010).

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Given the growing role of PAs in primary care and the importance of communication between health care providers and patients in that setting, it is surprising that little empirical attention has been paid thus far to the communication skills of PAs or PA students. A particularly important focus for empirical attention in this context is the communication of empathy, which we explicate subsequently.

Empathy and empathic communication

Much research on health care providers' effective communication with patients has focused on empathy. Although at least eight conceptual definitions of empathy can be differentiated in the empirical and clinical literature (Batson, 2009), most definitions emphasize the ability to understand what another person is thinking or feeling (Preston & De Waal, 2002) and to share those thoughts and feelings (Damasio, 2003).

Empathic ability is distinguishable from empathic communication, in that the former reflects one's capability of understanding and sharing another person's thoughts and feelings, whereas the latter comprises the overt verbal and nonverbal behaviors through which empathy is conveyed. As illustrated next, the communication of empathy is paramount in patient–provider interactions in the health care setting.

Empathic communication by health care providers

Most research on empathic communication by health care providers focuses on the relationship between patients and physicians, rather than PAs. This literature confirms the benefits of empathic communication in the physician–patient relationship for both patients and their doctors. For instance, multiple studies demonstrate that empathic communication on the part of doctors translates into higher satisfaction on the part of their patients (e.g., Goodchild, Skinner, & Parkin, 2005; Hojat et al., 2010). Empathic communication by physicians is also related to symptom resolution and improvements in physiological and functional status (Stewart, 1996) and to patient adherence to prescribed treatment regimens (DiMatteo et al., 1993). Finally, greater levels of empathy on the part of physicians are associated with fewer medical errors (West et al., 2006) and better diagnostic ability (Barsky, 1981), as well as lower levels of physician burnout (Shanafelt et al., 2005) and a reduced likelihood of being sued for malpractice (Hickson et al., 2002).

Research on empathic communication by physicians and medical students is voluminous, whereas empirical attention to the same issue among PAs and PA students has been comparatively scarce. Among studies that have addressed this context, some have focused on empathic behavior in the treatment of specific pathologies. For instance, in a study that included NPs and certified nurse midwives (CNMs) as well as PAs, Martin and Bedimo (2000) examined attitudes and care practices for persons with HIV/AIDS. Their study, which surveyed 1,291 NP, CNM, and PA practitioners, found that higher levels of empathy translated into greater comfort with treating patients with HIV/AIDS and greater willingness to provide care to HIV-infected individuals. In a larger randomized sample of U.S. PAs, Talley, Ritzdorf, and Muma (2010) confirmed that the majority of PAs evidence high empathy and positive attitudes when it comes to treating patients with HIV/AIDS.

Overall, research supports the importance of empathic communication skills for PAs and PA students, yet comparatively little is known about what influences such skills. Most research has focused on utility of empathy training programs and interventions (Parkhurst & Ramsey, 2006), whereas less empirical attention has been paid to the possibility that empathic communication behavior among health care providers may have genetic antecedents. We address this possibility subsequently.

A genetic basis for empathic communication

Several studies—although few focused on health care providers—have investigated the possibility that empathic communication has a partly genetic basis. Much of that research has focused on variations in the human receptor gene for the peptide hormone oxytocin. Oxytocin is produced by the hypothalamus and is released into the bloodstream and also projected directly onto various parts of the brain, including the striatum, amygdala, and vagal motor and sensory nuclei (Uvnäs-Moberg, Arn, & Magnusson, 2005). Like any hormone, oxytocin is chemically active only on cells containing an oxytocin receptor, a molecular protein that enacts the hormone's instructions to affect cellular metabolism. In humans, the oxytocin receptor is encoded by the oxytocin receptor gene (*OXTR*), which appears on the third chromosome at location 3p25.

Some genes, including *OXTR*, evidence single-nucleotide polymorphisms, or SNPs, which represent variations in the DNA sequence that occur when one of the four nucleotides—adenine (A), thymine (T), cytosine (C), or guanine (G)—differs between paired chromosomes. Each SNP represents variations in the form of the gene that are called alleles.

Multiple studies have found that genotypic variation in several *OXTR* SNPs is associated with various forms of prosocial communication (Feldman, Gordon, Influs, Gutbir, & Ebstein, 2013; Floyd & Denes, 2015), including empathy (Wu, Li, & Su, 2012). In much of that work, groups of individuals evidencing different genotypes, or pairs of alleles, are compared to each other on their levels of empathy. For example, Rodrigues and colleagues (2009) genotyped adults on the *OXTR* SNP rs53576, which comes in three genotypes: AA, AG, and GG. They found that individuals homozygous for the G allele—that is, who carried the GG pattern—evidenced higher empathic ability than did those with one or two copies of the A allele (either AA or AG). Skuse et al. (2014) similarly reported that autistic children homozygous for the A allele on rs53576 showed impairments in the ability to recognize previously seen faces. Other *OXTR* SNPs also show associations with empathy. For instance, Montag et al. (2012) reported genotypic differences in empathy for the SNP rs2254298 (which also pairs the A and G alleles) using a sample of schizophrenic adults and healthy matched controls. Wu et al. (2012) also reported that the C allele on rs13316193 is associated with greater empathy.

These and similar studies focusing on individual SNPs have provided evidence that several *OXTR* SNPs have specific genotypes associated with greater empathic and prosocial communication. This observation led Schneiderman, Kanat-Maymon, Ebstein, and Feldman (2013) to explore the association between empathic communication and genotypic variation using a "cumulative risk" approach. After genotyping five specific SNPs, Schneiderman et al. calculated a sum for each individual representing the number of SNPs (from 0 to 5) for which the individual had one of the less-empathic genotypes (such as AA or AG on rs53576). This approach produced a continuous score, which Schneiderman and colleagues found to predict difficulties in empathic communication between partners in new romantic relationships: The greater the number of SNPs on which an individual carried alleles associated with lower empathy (i.e., "risk alleles"), the greater the difficulties that individual evidenced in empathic communication with a loved one.

No study would support the claim that all of the variation in empathic communication has a genetic basis. Nonetheless, these research findings provide compelling evidence for a statistically significant association between genotypic variation—at least, on the *OXTR* gene—and empathic communication behavior. In the present study, we explore this association using the cumulative risk paradigm employed by Schneiderman and colleagues but using six *OXTR* SNPs rather than five for greater coverage. Specifically, we predict that cumulative genetic risk on six SNPs—rs13316193, rs2254298, rs1042778, rs2268494, rs2268490, and rs53576—is inversely associated with perceptions of PA students' empathic communication made by instructors (H1), observers (H2), and standardized patients (H3).

Method

Participants

Participants were 38 students enrolled in the first year of a 2-year master of science degree in physician assistant studies at a graduate school of health sciences in the southwestern United States, 8 clinical instructors in the same department, 114 undergraduate communication students at a major research university in the southwestern United States, and 13 standardized patients. Among the PA students, there were 14 men and 24 women whose ages ranged from 21 to 45 years (M = 28.03 years, SD = 5.60). The majority (84.2%) identified as Caucasian, whereas 15.8% were Asian/Pacific Islander, 5.3% were Native American/Alaskan, and 5.3% claimed other ethnic backgrounds (these percentages sum to >100 because participants could claim more than one ethnicity). At the time of the study, all students had completed a baccalaureate degree, and five had also completed a master's degree in another field. Among the communication students, 51 were male, 62 were female, and the rest declined to indicate their sex. Five out of eight of the clinical instructors were male, and seven out of 14 standardized patients were male. No other demographic information was collected from the communication students, instructors, or standardized patients.

Procedure

Students were recruited from among the entire first-year PA student class, via an e-mail announcement from the PA department chair and a verbal presentation to the class from the first author. Out of 50 students in total, 38 volunteered to take part in the study (a response rate of 76%). They were first directed to a website to complete an online questionnaire that collected demographic information and assessed their trait level of empathy.

On three subsequent occasions, students conducted mock clinical interviews with professional standardized patients (SPs). SPs are lay people trained to portray common clinical complaints in a simulated medical environment (Van Zanten, Boulet, & McKinley, 2007). In all, 13 SPs worked with the research team on this study. The SPs had an average of 3.38 years of work experience as standardized patients. All were trained by the third author to accurately role-play case details and to rate PA students' empathy. The third author has worked professionally as a standardized patient educator and medical education assessment consultant since 2007. Seven SPs were used for each round of clinical interviews. SPs received approximately 4 hours of training before each round of interviews, and were paid for their time spent in training and in interviews.

For each round of interviews, SPs were trained to present with symptoms indicative of a specific pathology. During the first round, SPs were trained to portray symptoms consistent with hypertension. In the second round, they depicted a neurological disorder/headache, and in the third round, symptoms consistent with chronic obstructive pulmonary disorder (COPD). In each case, a complete cover story about the SPs' personal and professional life, medical history, habits, and symptoms was constructed and used in training.

The clinical interviews took place at the health sciences university in rooms equipped with medical examination tables. In each interview, students greeted their assigned SP and asked questions about symptoms and lifestyle intended to lead to a differential diagnosis. During the second and third round of interviews, they also conducted a physical examination. Each interview was audio- and videotaped, and was also observed live via closed circuit TV by clinical instructors in the PA program.

Immediately following each clinical interview, SPs and clinical instructors both completed assessments of the students' empathic communication. Subsequently, undergraduate students at a different university watched each interview as third-party observers and assessed students' empathic communication, allowing an assessment of the PA students' empathic abilities from the perspective of a lay and uninvolved observer. Thus, each student received three separate evaluations of his or her empathy for each of three interviews.

During the first round of interviews, students also provided saliva samples for genotyping. Approximately 4 mL of saliva was collected from each student into marked plastic cryovials via stimulated passive drool. Samples were immediately frozen before being shipped on dry ice to a professional service laboratory for genetic analysis. The procedure was approved by the university's bioscience institutional review board. Some aspects of the method are also reported in Floyd, Generous, Clark, Simon, and McLeod (2015), a paper that compared the reports of the PA students' empathic communication but did not include any of the genetic data reported herein.

Measures

Students' empathic communication (as reported by instructors, SPs, and third-party observers) was measured by a modified version of the Jefferson Scale of Patient Perceptions of Physician Empathy (Kane, Gotto, Mangione, West, & Hojat, 2007). The five-item Likert-type scale elicits assessments of empathic communication behaviors performed by a health care provider during a specific patient interaction. Modifications were to replace the term "physician" with "physician assistant" and to create third-person versions of the measure. The current study employed 9-point scales in which higher scores reflect greater empathy. Internal reliability estimates for times 1, 2, and 3 were acceptable for instructors (.95, .97, .97), observers (.92, .93, .95), and SPs (.91, .96, .89), respectively. Descriptive statistics and intercorrelations appear in Table 1.

Six single-nucleotide polymorphisms on the oxytocin receptor gene were genotyped for each student. The six *OXTR* SNPs were rs13316193, rs2254298, rs1042778, rs2268494, rs2268490, and rs53576. Genotyping was performed from DNA extracted from students' saliva samples by Salimetrics LLC, a professional service laboratory, in accordance with procedures described by Schneiderman et al. (2013). A modified PureLink Genomic extraction method was used to isolate DNA from passive drool. TaqMan SNP Genotyping Assays (Applied Biosystems/LifeTech) were then used to amplify and detect alleles for *OXTR* SNPs. For each SNP analysis, polymerase chain reaction (PCR) amplification was performed by an Applied Biosystems 7500 real-time PCR machine using sequence-specific DNA primers and TaqMan PCR universal mastermix.

OXTR cumulative risk scores were calculated by assigning for each SNP a value of 1 to the risk allele (identified by previous research as being least associated with prosocial behavioral tendencies) and a value of 0 to all other alleles, and then summing the scores for all six SNPs. For each student, this resulted in a cumulative risk score with a theoretic range of 0 to 6. Descriptive statistics and intercorrelations with other study variables appear in Table 1.

Distributions for all genotypes, including risk alleles, appear in Table 2. All six distributions were in Hardy–Weinberg equilibrium, which suggests that the frequencies of these genotypes are likely to remain constant from one generation to the next in the absence of disturbing factors such as mutations, genetic drift, or nonrandom mating (e.g., Moonesinghe et al., 2010).

Table 1. Descriptive statistics and intercorrelations for study variables.

Variable	Low	High	*M*	*SD*	1	2	3
1. Instructor empathy score	4.33	8.80	6.35	1.22	—		
2. Observer empathy score	3.73	8.33	6.31	1.14	.34*	—	
3. Patient empathy score	2.20	8.73	6.31	1.30	.38**	.35*	—
4. Cumulative genetic risk	0.00	3.00	0.88	1.00	−.34*	−.24	−.18

Note. Empathy scores represent aggregates of time 1, 2, and 3 scores for instructors, observers, and standardized patients. Empathy measures employed 1–9 scales wherein higher scores indexed greater empathic communication. Probabilities are two-tailed.
$^{*}p < .05$; $^{**}p < .01$.

Table 2. Genotypic distributions for six single-nucleotide polymorphisms on the oxytocin receptor gene.

SNP	Risk allele (*n*)	Allele form two (*n*)	Allele form three (*n*)
rs53576	AA (6)	AG (16)	GG (14)
rs1042778	TT (4)	GT (16)	GG (18)
rs2268494	AA (36)	AT (2)	—
rs13316193	TT (6)	CT (20)	CC (12)
rs2254298	GG (24)	AA (14)	—
rs2268490	TT (1)	CT (13)	CC (24)

Note. SNPs rs2254298 and rs2268494 exhibited two genotypes only.

Results

The hypotheses proposed that PA students' cumulative risk score on the *OXTR* receptor gene predicted the evaluations of students' empathic communication made by of instructors (H1), observers (H2), and standardized patients (H3). We used hierarchical regressions to test the hypotheses. To mitigate alpha inflation, given that we had three assessments each of students' empathic behavior (at time 1, time 2, and time 3, as rated by instructors, observers, and patients), we calculated criterion variables by aggregating the evaluations of each rater across the three time periods (e.g., instructors' score for students' empathy was the average of the instructors' scores at times 1, 2, and 3).

Hierarchical regressions controlling for the age and sex of the PA student found that cumulative risk was a significant predictor of students' empathic communication as evaluated by instructors, $\beta = -.44$, $p = .01$, in support of H1, and by observers, $\beta = -.35$, $p = .046$, in support of H2. Cumulative risk was a nonsignificant predictor of students' empathic communication as evaluated by standardized patients, $\beta = -.12$, $p = .50$, contrary to H3. Complete regressions results appear in Table 3 for instructor evaluations and in Table 4 for observer evaluations. H1 and H2 are both supported, whereas H3 is not.

For exploratory purposes, we also analyzed instructors', observers', and standardized patients' evaluations of PA students' empathic communication by comparing mean differences between groups with each genotype on each SNP. For

Table 3. Hierarchical regression predicting instructors' aggregated reports of state empathic communication.

Step	Variables	*B*	*SE B*	*β*	ΔR^2
1.	Student age	−.01	.04	−.06	.01
	Student sex	−.33	.49	−.13	
2.	*OXTR* genetic risk	−.56	.21	−.44*	.18*

Note. $R^2 = .19$; adjusted $R^2 = .12$; $F(3, 34) = 2.62$, $p = .067$.
$^{*}p < .05$.

Table 4. Hierarchical regression predicting observers' aggregated reports of state empathic communication.

Step	Variables	*B*	*SE B*	*β*	ΔR^2
1.	Student age	.05	.04	.22	.04
	Student sex	.31	.45	.13	
2.	*OXTR* genetic risk	−.40	.19	−.35*	.11*

Note. $R^2 = .15$; adjusted $R^2 = .07$; $F(3, 34) = 1.94$, $p = .14$.
$^{*}p < .05$.

rs53576, for instance, we conducted one-way analyses of variance (ANOVAs) with genotype as the independent variable and instructors', observers', and patients' evaluations as the dependent variables. (For rs2254298 and rs2268494, we used independent-samples *t*-tests in place of ANOVAs, given that each SNP had only two genotypes.) All of the mean comparisons were nonsignificant, suggesting the superiority of the cumulative risk approach over analysis of individual SNPs.

Discussion

This study examined the communication of empathy in the relationship between patients and students training to become physician assistants. Empathic communication is associated with multiple outcomes in the relationship between physicians and patients, so as PAs assume a continually greater role in primary care, it is worth investigating their empathic communication abilities as well.

Drawing on previous research linking empathic abilities to variations in specific single-nucleotide polymorphisms on the oxytocin receptor gene, we investigated the extent to which variance in empathic communication is accounted for genetically. Despite the tendency to think of empathic communication ability as wholly acquired (through training, socialization, enculturation, etc.), we identified significant proportions of the variance—at least, in instructors' and observers' assessments—that are accounted for by the students' genotypes. Moreover, the effect sizes linking instructors' and observers' evaluations to students' genetic risk measures were notable in magnitude, at $\beta = -.44$ for instructors and $-.35$ for observers, suggesting that the genetic effects are not trivial.

This finding certainly does not suggest that the influences of training, socialization, and other environmental factors on empathic behavior are negligible. Indeed, multiple studies have shown that empathic ability can be improved through instruction and practice (e.g., Parkhurst & Ramsey, 2006). The present findings do suggest, however, that empathic behavioral tendencies are, to some extent, innate, meaning that there are perhaps ceiling effects in the efficacy of training and instruction for empathic communication.

To explore the possibility of a ceiling effect, we performed a median split on the cumulative risk scores and then compared the T1, T2, and T3 data separately for high- and low-risk groups. For patient and instructor ratings, the repeated-measures tests were significant for the low-risk group but not for the high-risk group. Therefore, scores for high-risk group—besides being lower than those for the low-risk group—remained stable over time, lending support to the idea of a ceiling effect for training efficacy. Scores in the low-risk group evidenced a quadratic effect, in which they demonstrated the highest empathic communication at T2, and lower empathic communication at T1 and T3. (Full statistical results for these exploratory analyses are available on request.)

Adopting a cumulative risk approach to examining genotypic variation was useful, insofar as it represents a continuous approach to indexing the genetic signatures previously associated with prosocial behavior, making patterns of covariation easier to identify. Indeed, had we tested our hypotheses simply by comparing the various empathy assessments for each SNP individually (via a *t*-test or one-way ANOVA, as is often done), instead of adopting a collective, continuous approach, we would have failed to identify these patterns, as the individual discrete comparisons were always nonsignificant.

Contrary to our prediction, students' cumulative risk scores were not a significant predictor of their empathic abilities as perceived by standardized patients, although the relationship was in the expected direction. Given the magnitude of the relationships between students' genetic risk scores and the assessments of their empathic ability made by instructors and observers, it is surprising not to see the same emerge for patients' perceptions. The failure to identify a significant relationship with patients' evaluations cannot be attributed to lower variance in patients' scores, as the standard deviation in patients' scores was actually slightly greater than those of instructors and observers. Because the patients (unlike the instructors and observers) were enacting their standardized presentations of symptoms in each clinical interview, their attention may have focused on more immediate behavioral clues in students' performances, and perhaps on smaller, more discrete behaviors than were perceivable by instructors and observers, who watched the interviews via closed-circuit television. Future research would benefit by addressing more fully the antecedents of patients' perceptions of empathy in the PA–patient relationship, given the possibility that students' genotypes—at least, with respect to the six single-nucleotide polymorphisms we examined—do not account for significant proportions of the variance.

With regard to instructors' and observers' assessments of students' empathic communication, some may be inclined to dismiss our findings as suggesting that empathic behavior is wholly determined genetically. If that were the case, then efforts to teach and practice empathic communication skills—which are supported by the U.S. accrediting agencies for both medical schools (Liaison Committee on Medical Education, 2013) and PA schools (Accreditation Review Commission on Education for the Physician Assistant, 2010)—would be futile. This conclusion reflects a biological or genetic determinism that the current findings simply do not support. Although students' *OXTR* cumulative risk scores accounted for substantial proportions of the variance in instructors' and observers' ratings of students' empathic behaviors, they did not come close to accounting for 100% of the variance in either case. This leaves significant proportions of the variance likely attributable to acquired abilities, such as those attained through training and practice.

Rather, the present findings suggest that some students enter their PA training with an advantage in empathic abilities, relative to other students, that has a genetic basis. This ought not to be a controversial finding, insofar as individuals routinely enter both professional and personal spaces with advantages over others—such as physical attractiveness, intelligence, height, physical strength, and sensory acuity—all of which have at least a partly genetic basis. This certainly does not negate the utility of training; a basketball player still benefits greatly from quality coaching and constant practice, even if he or she brings advantageous height and strength that are the product of genetics. Similarly, although some PA students may enter their training with a greater natural ability than their fellow students to empathize, this merely gives them a head start in developing their empathic communication skills through the training and practice they receive as part of their education.

Like all studies, this one benefited from certain methodological features and was constrained by others. Conducting assessments and observations as an integral part of the PA students' training—rather than as a side activity—bolstered the external validity of our clinical interviews. The use of standardized patients, although perhaps a detriment to external validity, increased the internal validity of the study by maximizing consistency in the stimuli to which the students were asked to attend. Similarly, having multiple ratings of empathic communication at each time period provided a broader look at the students' empathic abilities than any single perspective could have offered.

The inclusion of genotypic assessment as an independent variable in the current study allowed for identification of some portions of the variance in students' empathic behavior that are innate rather than acquired. Again, this is not to diminish the force of environmental contributions to empathy, but rather to understand their scope more precisely. At the same time, the present study went beyond previous efforts at linking genotypic variation to empathic ability by focusing on the communication of empathy, rather than simply on one's skill at decoding and interpreting the signals of others.

Perhaps the most significant limitation was the sample size of 38 students. Given that statistically significant effects emerged, the sample size obviously provided adequate statistical power, yet small samples attenuate external validity, and there would be merit in replicating these observations with a larger sample.

An important next step in this research would be to implement pedagogical approaches for increasing empathic communication behavior among PA students and then to determine whether they are more effective for students with some genotypes than others. According to existing research with health care providers, discussed in the preceding, a PA's ability to convey a sense of empathy is likely associated with numerous benefits for patients and providers alike. Developing training units aimed at teaching and rehearsing empathic communication skills—and then testing their efficacy experimentally—would be a beneficial extension of this research.

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