Individual and gender differences demonstrate a trade-off between empathetic concern and physical reasoning abilities

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Transdisciplinary approaches to the mind

The Extreme Male Brain (EMB) theory of Autism has provided the primary structure through which the study of individual differences in empathetic and analytic abilities in the general population has been approached. It is based on the idea that women are more empathetic while men are more analytic. This characterization of males and females does not reflect empirical findings based on measures of these constructs: studies show inconsistently gender differences in empathy, and no clear correlation between the two abilities has been found. In the present study, we aim to provide a new foundation to understand individual differences in analytic and empathetic reasoning abilities, but instead of viewing this relationship as a dyad, we acknowledge three distinct sets of abilities that are interplaying: physical reasoning, intentional reasoning (thinking of the intentions or explicit emotions of others), and phenomenal reasoning (thinking of others as experiential beings with moral concern). In a series of five experiments, we find that across the population there is an inverse correlation between measures in the physical and phenomenal stances; neither correlated consistently with the intentional stance. Males were found to be better in physical reasoning while females performed better in phenomenal reasoning; however, the inhibitory relationship between empathetic concern and physical reasoning was still present when we controlled for gender and demographic characteristics, including education. We believe that there is a trade-off between having empathetic concern for others and having superior physical reasoning abilities, acknowledging that abilities in "empathy" are two separate factions of reasoning.

Introduction

In examining the reciprocally inhibitory relationship between the Task Positive Network (TPN) and the Default Mode Network (DMN), we (in Jack et al. 2012) provide evidence supporting the opposing domains hypothesis. This hypothesis states that the inhibitory relationship between the networks reflects incompatible cognitive modes which can be directed towards understanding the external world. These modes are associated with two broad cognitive domains: social information processing and non-social, physical, information processing. In our evaluation, we found that social reasoning tasks produced a pattern of activation in the DMN, while physical reasoning tasks produced activation in the TPN; both of these tasks produced deactivation in the opposite networks.

We use this pattern of reciprocally inhibitory networks for social and physical reasoning to support the model of perceiving objects we proposed in Jack & Robbins, 2012. We believe that there are three stances of perceiving objects: the Physical stance, the Phenomenal stance, and the Intentional stance (**Figure 1** below). As observed in Jack et al. 2012, this model also includes a system of mutual antagonism between viewing an object with a Physical stance (governed by mechanical principles) or a Phenomenal stance (as a locus of experience).

In this model, we make a distinction between the Phenomenal and Intentional stance to illustrate that social cognition varies in how it integrates reasoning: whereas the Phenomenal stance is emotionally engaged and focused on representing experiential states, the Intentional stance is emotionally disengaged and recruits areas associated with the TPN in order to manipulate and transform representations of internal mental states.

In observing the results of Jack et al. 2012 and its implications on the model of three cognitive stances, we questioned whether this inhibitory relationship between the Physical and Phenomenal stances, and independence of the Intentional stance (viewing an object as having intentions; using analytic processes to manipulate mental representations), could be used to represent individual differences in reasoning abilities.

Similar research has been done on individual differences in social and physical reasoning abilities by Simon Baron-Cohen and colleagues, specifically in evaluating the Empathizing-Systemizing (E-S) theory of Autism Spectrum Conditions (ASCs). They have provided much data in support of the E-S theory, which characterizes individuals with ASCs as having decreased abilities in empathizing, and increased abilities in systemizing, 'the drive to construct and analyze the variables in systems' (Baron-Cohen, 2002).

Baron-Cohen and colleagues have also extended the E-S theory to reflect cognitive differences among the general population, titled the Extreme Male Brain (EMB) theory of Autism. They observe that in a pattern similar to ASCs, males are better at systemizing and worse at empathizing than females. Therefore, Autism can be seen as an extreme form of the male brain, as it reflects a more exaggerated version of the same reasoning phenotype.

In supporting the E-S theory of autism, Baron-Cohen and colleagues have shown that individuals with ASCs are better at spatio-visual tasks, but have deficits in emotional decoding, Theory of Mind (ToM) tasks, and socio-communicative behaviors.

However, there is insufficient data to create the male and female reasoning phenotypes that the EMB is built off of. No correlation between measures of empathizing and systemizing, aside from the 'Empathizing Quotient' and 'Systemizing Quotient,' has been found in the general population. Therefore, it is questionable whether we can view this as a legitimate trade-off in abilities. They have provided inconsistent findings about the gender differences in Empathizing: differences in emotional decoding and ToM measures were found in Lawson, Baron-Cohen, & Wheelwright, 2004, but not in Baron-Cohen et al. 2001 and Lai et al. 2012. The foundation of the EMB theory, that differences exist between males and females in empathizing and systemizing, is unsupported by the data they have presented.

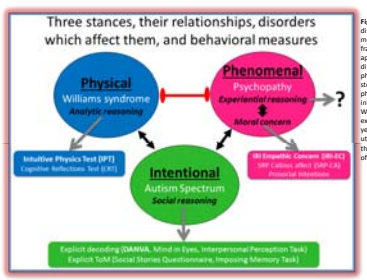

Figure 1 Three stances, their relationships, disorders which affect them, and behavioral measures. This model guides our theoretical framework through which we are approaching the study of individual differences and gender differences in physical and empathetic reasoning. The red stop-arrow between the physical and phenomenal stance is used to signify a inhibitory relationship between the stances. We have a question mark for measures of experiential reasoning because we have not yet found a test to adequately measure the utilization of this process, though we suspect that it would possibly be an implicit measure of Theory of Mind.

Objective

In a series of 5 experiments, we sought to test the application of the Extreme Male Brain (EMB) theory of Autism onto the general population against our three stance theory as a model of understanding individual differences between empathetic and analytic thinking abilities. We believe that Baron-Cohen's lack of a sufficient trade-off and gender differences in the general population is a result of a failed distinction: they looked for a trade-off between non-social reasoning and intentional reasoning, using measures of emotional decoding and explicit theory of mind. According to our model, this is an examination of the relationship between the Intention and Physical stances, and should reveal no differences. Instead, by making a distinction between Intentional and Phenomenal reasoning, and by examining the relationship between differences in Phenomenal and Physical reasoning among the general population, we hypothesize a trade-off among the general population will become apparent.

Experiments 1-3 used different measures considered in our hypothesized Physical and Phenomenal stances in order to establish a significant and consistent trade-off among the general population. Experiments 4 & 5 added measures in the hypothesized Intentional stance in order to test a possible relationship between this stance and the Physical and Phenomenal stances. Experiments 1 – 4 were conducted online using Amazon's Mechanical Turk to recruit participants to fill the measures hosted on SurveyMonkey, while Experiment 5 recruited participants from the undergraduate population of CWRU.

Methods

Experiments 1 – 4

Participants from Experiments 1 – 4 were recruited using Amazon's Mechanical Turk (MTurk), where participants were directed to our survey, hosted on SurveyMonkey. Participants were required to have an Mturk HIT approval rating of 95%, and to have previously completed a minimum of 50 HITs. The number of participants included in each experiment can be found on Table 1 below. In order to make sure that participants were paying attention to the survey, we included quality control questions. Participants who failed to correctly answer the quality control questions had their HITs rejected and their data excluded from analyses. Measures used in Experiments 1 – 4 included: The Intuitive Physics Test (IPT; Baron-Cohen, 2001), the Interpersonal Reactivity Index subscale Empathetic Concern (IRI-EC; Davis, 1980), Self-Reported Psychopathy subscale Callous Affect (SRP-CA; Paulhus, Neumann, & Hare, in press), the Cognitive Reflection Test (CRT, Frederick, 2005), Prosocial Intentions (Pavey, Greitemeyer, & Sparks, 2011), and the DANVA facial recognition task (Nowicki & Duke, 2000). Measures were included in each survey in the following order:

Experiment 1: demographic questions, IRI-EC, IPT
Experiment 2: demographic questions, IPT, IRI-EC and SRP-CA, CRT
Experiment 3: demographic questions, IPT, IRI-EC and SRP-CA, CRT, Prosocial Intentions
Experiment 4: demographic questions, IRI-EC and SRP-CA, the DANVA, IPT

Experiment 5

Participants from Experiment 5 were drawn from the undergraduate population of Case Western Reserve University and participated in a comprehensive study of social cognition involving two laboratory sessions of up to three hours, separated by a number of online surveys which participants completed in their own time. Payment for participation was variable, depending partly on performance. Only 82 participants (43 female, average age 19.85, SD=1.23) are included in the analysis, as they are the selection who completed all of the measures of interest here.

Participants completed computerized (E-prime 2.0) versions of well-established measures of social function: the Imposing Memory Task—theory of mind subscore (Kinderman, Dunbar, & Bentall, 1998), the Social Stories Questionnaire (Lawson, Baron-Cohen, & Wheelwright, 2004), the Mind in the Eyes test revised version (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001), the Interpersonal Perception Task (Costanzo & Archer, 1989), and DANVA facial emotion recognition task (Nowicki & Duke, 2000). The Cognitive Reflections Test (CRT) and Intuitive Physics Task (IPT) were also administered in computerized laboratory versions. The Empathetic Concern scale of the Interpersonal Reactivity Index (IRI-EC) and the Callous Affect subscale of the Self-Reported Psychopathy scale (SRP-CA) were administered using online surveys, hosted on SurveyMonkey.

Results

	IRI Empathetic Concern Scale				IRI-EC & IPT		Mechanical Reasoning (IPT)		
	n	Gender	Age	Education	Bivariate	Partial	Gender	Age	Education
Experiment 1	321	.170**	-.042	-.076	-.259**	-.235**	-.165**	.052	.045
Experiment 2	236	.288**	.179**	-.037	-.181**	-.136*	-.197**	.052	.143*
Experiment 3	233	.264**	.118	-.046	-.230**	-.181**	-.272**	.088	.018
Experiment 4	339	.255**	.209**	.063	-.137**	-.074	-.264**	-.045	.043
Experiment 5	82	.400**	-.095	-	-.298**	-.146	-.421**	.187	-

Table 1 Correlations between the IRI-EC and demographic information, the IRI-EC and the IPT, and the IPT and demographic information. All experiments reported in this paper are included. Coefficients are significant at $p<.05$* and $p<.01$**. Correlations with demographic information were analyzed with two-tailed significance, while correlations between the IRI-EC and the IPT were analyzed with one-tailed significance. Gender, 1 = male, 2 = female. Across all experiments, we find a trade-off between moral concern, as measured with the IRI-EC, and analytic thinking, measured by the IPT. Consistent gender differences were also found with scores on the IRI-EC and the IPT in opposite directions. However, partial correlations, controlling for gender, age, and education (when applicable), suggest that the trade-off between IRI-EC and IPT did not occur because of gendered effects.

Correlations with Mechanical Reasoning (IPT)

	N	Gender	Age	Education	CRT	IRI-EC	SRP-CA	Prosocial Intentions	DANVA	Imposing Memory Task	Social Stories Questionnaire	Mind in Eyes	Interpersonal Perception Task
Experiment 1	321	-.165**	.052	.045	-	-.259**	-	-	-	-	-	-	-
Experiment 2	236	-.197**	.052	.143*	.310**	-.181**	.146*	-	-	-	-	-	-
Experiment 3	233	-.272**	.088	.018	.265**	-.230**	.160*	-.193**	-	-	-	-	-
Experiment 4	339	-.264**	-.045	.043	-	-.137**	.118*	-	.113*	-	-	-	-
Experiment 5	82	-.421**	.187	-	.332**	-.298**	.233*	-	.200	.127	.111	.025	.153

Table 2 Correlations between the IPT and demographic information, and the IPT with all measures tested. All experiments reported in this paper are included. Coefficients are significant at $p<.05$* and $p<.01$**. Gender, 1 = *male*, 2 = *female*. All correlations were analyzed with two-tailed significance except for the relationship between IPT and IRI-EC. Analyses showed reliable significant relationships with the CRT (positive), IRI-EC (inverse), and the SRP-CA (positive), suggesting a trade-off between measures in the Physical and Phenomenal stances. A significant inverse correlation was found with Prosocial Intensions, and a significant positive correlation was found with the DANVA facial recognition task; this continues to support our hypothesized trade-off between Physical and Phenomenal stances, while the DANVA suggests no inhibitory relationship between the Physical and intentional stances.

Correlations with IRI Empathetic Concern Scale

	N	Gender	Age	Education	IPT	CRT	SRP-CA	Prosocial Intentions	DANVA	Imposing Memory Task	Social Stories Questionnaire	Mind in Eyes	Interpersonal Perception Task
Experiment 1	321	.170**	.042	-.076	-.259**	-	-	-	-	-	-	-	-
Experiment 2	236	.288**	.179*	-.037	-.181**	-.169**	.748**	-	-	-	-	-	-
Experiment 3	233	.264**	.118	-.046	-.230**	-.162*	-.194**	.361**	-	-	-	-	-
Experiment 4	339	.255**	.209*	.063	-.137**	-	-.746**	-	.066	-	-	-	-
Experiment 5	82	.400**	-.095	-	-.298**	-.092	-.597**	-	.015	.044	.175	.140	-.095

Table 3 Correlations between the IRI-EC and demographic information, and the IRI-EC with all measures tested. All experiments reported in this paper are included. Coefficients are significant at $p<.05$* and $p<.01$**. Gender, 1 = *male*, 2 = *female*. All correlations were analyzed with two-tailed significance except for the relationship between IPT and IRI-EC. Analyses showed reliable significant inverse relationships with the IPT, CRT, and SRP-CA, suggesting a trade-off between measures in the Physical and Phenomenal stances. A significant positive correlation was found with Prosocial Intensions, while no significant relationship was found with the explicit decoding or explicit ToM tasks; this continues to support our hypothesized trade-off between Physical and Phenomenal stances, with separate categorization of Phenomenal and intentional reasoning abilities.

Discussion

With Experiments 1 – 5, we find enough evidence to support the application of the three stance model to understand individual differences. Using the Intuitive Physics Test (IPT) of mechanical reasoning in the Physical stance and the Interpersonal Reactivity Index's Empathetic Concern (IRI-EC) scale in the Phenomenal stance as the primary measures for evaluation, we consistently saw an inverse correlation between the Physical and Phenomenal stances; additional measures in these stances continued to paint this same trade-off. See the figure below to see a summary of the Pearson bivariate correlational relationships between all measures in Experiments 1 – 5.

Additionally, no clear relationship was discovered between measures in the hypothesized Intentional stance with the hypothesized Phenomenal stance, negating previous models of individual differences like the Empathizing-Systemizing (E-S) theory of Autism that considers a more broad definition of 'empathy,' which includes explicit experimental measures. In considering a trade-off between analytic and empathetic measures, our data suggests that explicit measures of empathy, like the DANVA facial emotion recognition test or the Mind in the Eyes test, should not be used to measure individual differences on the empathetic side. The trend for measures in the Intentional stance to correlate positively with measures in the Physical stance suggests that performance on Intentional measures is partially based on analytic abilities shared with the Physical stance. Since we have established an inverse relationship between the Phenomenal and Physical stances, and with the requirement of analytic thinking in both the physical and intentional stances, we believe that the Intentional stance should be considered more of a blend between the Physical and Phenomenal. We believe our data suggests that measures in the Intentional stance should not be used as the foundation for understanding broad empathetic abilities in individual differences.

Focusing on our primary measures of the IPT in the Physical stance and the IRI-EC in the Phenomenal stance, across experiments we saw a trend for an inverse relationship between these stances to occur, even when controlling for gender (see **Table 1**). Baron-Cohen and colleagues have extended their E-S theory of Autism into the Extreme Male Brain (EMB) theory of Autism, which states that women are more empathetic while men are more systematic; therefore, Autism Spectrum Conditions (ASCs) can be seen as an extreme version of the male phenotype as individuals with ASCs are often even better at systemizing and worse at empathizing then men. Although we do not make a claim about the characterization of ASCs, our data suggests that viewing gender differences as reflecting a trade-off between analytic and phenomenal-empathetic does not capture the whole picture. The characterization of men as more analytic and women as more phenomenally empathetic can be seen in our correlational analyses, but inverse correlations between the Phenomenal and Physical stances still occur when isolating a single gender or while controlling for gender in partial correlational analysis. We find that a trade-off between analytic thinking and empathetic concern does occur in individual differences, but effects of gender should not be the focus of this trade-off. In fact, research indicates that cultural differences may be responsible for gender differences in analytic abilities (Guiso et al., 2008)

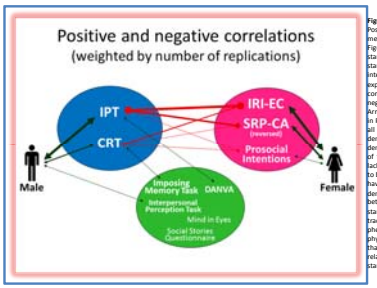

Figure 2 Positive and negative correlations between measures in the three stances. As mirrored in Figure 1, the blue circle denotes the physical stance, the pink circle denotes the phenomenal stance, and the green circle denotes the intentional stance. Measures used in each experiment are included here. Positive correlations are signified with a green arrow, negative correlations are signified with a red bar. Arrows are weighted by number of replications in Pearson bivariate correlational analysis across all experiments., with the thinnest arrows denote one replication and the thickest denoting five. We used a reverse-scored version of the SRP-CA as it measures callous affect, or lack of moral concern for others; this means that to be more in the phenomenal stance you would have a lower SRP-CA score. The figure demonstrates a clear inverse relationship between the physical and the phenomenal stances, and that gender interacts in the tradeoff such that females engage more of the phenomenal while males engage more of the physical stances. Our data failed to demonstrate that the intentional stance shares a reliable relationship with either gender, the physical stance, or the phenomenal stance.

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