The role of executive function and theory of mind in pragmatic computations

According to a widely influential view of communication (Grice, 1975), listeners understand the literal, *semantic* meaning of an utterance but can also "read between the lines" to contextually enrich the semantic meaning with *pragmatic* inferences constrained by the speaker's intentions. Often the semantic and pragmatic meanings diverge (as in under-informative sentences such as "Some giraffes have long necks") and listeners vary in whether they adopt the pragmatic or logical meaning of these utterances within a task (Noveck, 2001; Guasti et al., 2005). Assuming that pragmatic responding should best be treated as a continuum (cf. Degen & Tanenhaus, 2015; Fairchild & Papafragou, 2017), *why* should such individual variation in pragmatic judgments exist? A reasonable hypothesis is that stable participant characteristics can shift individuals' responses from more to less pragmatic. For instance, Gricean accounts expect Theory of Mind (ToM) abilities to be linked to pragmatics, whereas other theorists (De Nys & Schaeken, 2007) have proposed that Executive Function (EF) should predict differences in pragmatic reasoning. The relative contributions of ToM and EF to pragmatic computations in neurotypical adults, however, remain contested and have not generally been compared at the same time and across several pragmatic phenomena. We do so here.

Exp. 1. Two hundred monolingual English speakers recruited on MTurk completed the following: (a) a Dual Task (in which they remembered a simple or complex dot pattern as they performed a secondary reasoning task) and an Auditory Digit Span Task, both of which served as EF measures, (b) a Scalar Implicature (SI) Task, in which they read under-informative and informative sentences and rated each on a scale from 1 (Very Bad – Doesn't make sense) to 5 (Very Good – Makes perfect sense), (c) the Mind in the Eyes (Baron-Cohen et al., 1997) and Strange Stories Tasks (Happé, 1994) as ToM measures. A composite EF measure was derived by taking the sum of the *z*-scores calculated from participants' scores on the two separate EF tasks (a composite ToM score was similarly created). Critically, the SI Task results were related to the EF and ToM measures.

A Pragmatic Difference Score (PDS) was calculated by subtracting the number of times Informative sentences were judged as "Bad" by an individual participant from the number of times Under-Informative sentences were judged as "Bad" in the Scalar Implicature Task. A multiple linear regression was conducted with the composite EF and ToM scores as independent variables and PDS as the dependent variable. The model accounted for a significant amount of variance, $F(2, 175) = 18.250$, $p < .001$ (Table 1). EF was not significantly associated with PDS but ToM was significantly positively associated with PDS. Participants who performed better on ToM – but not EF – tasks behaved more pragmatically on the SI task.

Exp. 2. Two hundred monolingual English speakers completed three pragmatic tasks (Metaphor, Indirect Request, SI), an Auditory Digit Span Task (EF), and the abridged Mind in the Eyes and Strange Stories Tasks (ToM tasks). For the Metaphor Task, participants rated metaphorical and literal phrases on 5-point meaningfulness scale. For the Indirect Request Task, participants saw picture-sentence pairs, some of which contained indirect requests (see Table 2), and answered the question "How much do you feel that the speaker wants something from you?" on a 5-point scale. All other tasks were identical to Exp.1. Results replicated Exp.1 for SI and generalized to the Indirect Request (Table 3), but not the Metaphor task (for reasons that we attribute to the nature of the novel metaphors we used). We conclude that, as predicted by broadly Gricean accounts, differences in ToM (but not EF) are associated with pragmatic competence across distinct pragmatic phenomena.

Table 1.
Multiple linear regression predicting Pragmatic Difference Score (the number of "Bad" ratings of Under-Informative sentences minus the number of "Bad" ratings of Informative sentences in the Scalar Implicature task) in Experiment 1 from EF and ToM scores.

Effect	*β*	*S.E.*	*t*	*p*
Intercept	2.927	0.151	19.387	<.001
EF	0.173	0.099	1.741	0.083
ToM	0.491	0.103	4.754	<.001

Table 2.
Examples of stimuli used in the Indirect Request Task in Experiment 2 (borrowed from Van Ackeren et al., 2012).

Picture	Sentence	Trial Type
	It is very hot here.	Indirect Request
	It is very nice here.	Picture Control
	It is very hot here.	Utterance Control
	It is very nice here.	Picture-Utterance Control

Table 3.
Multiple linear regression analyses predicting Pragmatic Difference Scores (PDSs) on the Indirect Request and Scalar Implicature tasks in Experiment 2 from EF and ToM scores.

	Indirect Request		Scalar Implicature	
Effect	*β* (*S.E.*)	*p*	*β* (*S.E.*)	*p*
Intercept	0.726 (0.053)	< .001	2.925 (0.149)	< .001
EF	0.037 (0.056)	.518	0.086 (0.160)	.591
ToM	0.177 (0.023)	<.001	0.473 (0.094)	< .001