Popularity, theory of mind and interaction in experiments: Meta-regression

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Abstract

This study aims at investigating how interaction in experiments affects effect size in studies on an association between Theory of Mind and popularity. The analysis included 1946 children from 17 studies. Meta-regression was employed to compare effect sizes of an interaction group with that of non-interaction. Compared with an interaction group, a non-interaction group are more likely to have a small effect size, indicating that researchers drop hints about what answer is needed in the experiments. The result is consistent, when adjusting for gender and when conducting a permutation test. The result indicates that interaction with researchers in experiments could have an impact on Theory of Mind studies.

Keywords

Theory of mind, popularity, meta-regression, meta-analysis

Introduction

Children with an advanced theory of mind (ToM) appear to be popular in the classroom [1]. However, it is possible that, without any ToM ability, children can understand what answer is needed. Children are able to infer others' thoughts from cues like facial expressions [2].

Although these cues are seen in practical situations, especially in the classroom, it is a kind of background noise in experiments and not the ability of ToM in the light of the classic ToM definition — systematic inferences of other people's unobservable mental state [3]. To avoid direct feedback, interaction with other people in experiments should be excluded, as faux pas tasks were once conducted by using an audiocassette [4].

Many ToM studies are however implemented directly by the experimenter. The experimenter, while hoping children may answer properly, probably gives children unintended cues causing them to ace ToM experiments. This has led to suggestions that there is room for recognizing some noise — interaction with researchers in experiments — in traditional ToM studies.

When children can read others' mind more accurately in any way, they are more likely to be popular in the classroom. As a result, this may have caused overestimation of effect sizes. An association between ToM and popularity may be biased, when cues are not accounted for in the experiment.

To deal with this problem, this study compares studies assessing ToM by computer with those assessing ToM in person because there is no room for overestimation when ToM is assessed by computer. This study uses meta-regression to estimate the actual difference in effect size between these studies. Meta-regression is an extended method of meta-analysis and widely used to investigate heterogeneity between studies. In this way, this study aims at reexamining an association between ToM and popularity in a new way.

Methods

Study selection

The electronic databases, Psych INFO and Google Scholar were searched for relevant articles in March 2017. Search terms were as follows: “popularity,” “sociometric,” “peer acceptance,” “peer likability,” “peer rejection,” “peer status,” “peer evaluation,” “peer nomination,” “peer relations,” “ToM,” “mindreading,” “mentalizing,” “false belief,” “mental representations,” “mind understanding,” and “mental states” as used in a previous meta-analysis [1]. The Japanese database, J-STAGE, was also used to collect articles in Japanese. Citation search was also conducted.

The following inclusion criteria were used (criteria (1) to (3) followed previous meta-analysis [1]):

- (1) Only healthy preschool or school-aged children under 10 years could participate.

- (2) ToM had to be assessed by more than one of false-belief understanding, hidden emotion, affective perspective-taking, or faux pas tasks.
- (3) Sociometric or perceived popularity had to be assessed by a peer or a teacher.
- (4) Effect size(s), N and gender ratio must be reported or convertible. An association between ToM and popularity was evaluated by Pearson correlation coefficient or r . If multiple coefficients were reported in a study, these were synthesized into one coefficient unless a study has multiple age groups.
- (5) Measures of ToM have to be identifiable (computer or person). Coding is organized based on whether ToM was assessed in person (e.g., researcher and experimenter) or by computer. Studies assessing ToM in person are categorized as an interaction group and those assessing ToM by computer are categorized as a non-interaction group.
- (6) Peer-reviewed articles were from publication in either English or Japanese.

Statistical analysis

This study uses random-effects meta-regression. Meta-regression can be seen as an extension to standard meta-analysis, and is rigorous as well as effective. The statistical software Stata 15.0 was used for all data analysis. The meta-regression algorithm was implemented by using version 2.6.1 of the *metareg* command [5]. Publication bias was assessed by using version 4.1.0 of the *metabias* command [6].

Result

According to criteria, 17 studies (22 effect sizes) were identified. Detailed characteristics were coded for each study and presented in Table 1. As shown, a total of 1946 children were included.

The result of meta-regression, without fitting any covariates, showed that effect size was associated with interaction in the experiments, $\beta = .134$ (95%CI .006 - .262), $p = .041$, and between-study heterogeneity (I^2_{res}) was 27.68%. After controlling for gender, the result was still consistent, $\beta = .137$ (95%CI .003 - .272), $p = .046$, $I^2_{\text{res}} = 30.82\%$.

To overcome the small sample size which increases the chance of a false-positive (type I) error, permutation analysis was implemented. The result was marginally significant ($p = .083$), indicating consistency with previous analyses. The result of Egger's test showed that publication bias was non-significant ($p = .735$). Taken together, these results indicate rejection of the null hypothesis — effect of interaction with researchers in experiments was zero.

Table 1
Characteristics of studies included in the meta-regression

Study	<i>N</i>	<i>r</i>	Girl ratio	Interaction	Assessment by	Note
Banerjee & Watling (2005) year 1 cohort [7]	113	0.07	0.52	No	a multimedia computer interface	synthesized (.08, .04, .09)
Banerjee & Watling (2005) year 4 cohort [7]	195	0.14	0.43	No	a multimedia computer interface	synthesized (.20, .09, .23)
Banerjee et al. (2011) younger group [8]	72	0.19	0.57	No	a multimedia computer interface	synthesized (.07, .16, .19, .05, .29, .39)
Banerjee et al. (2011) older group [8]	138	0.11	0.43	No	a multimedia computer interface	synthesized (.09, .23, .02, .11)
Braza et al. (2009) [9]	98	0.21	0.56	Yes	qualified, trained researchers	
Caputi et al. (2012) [10]	70	0.05	0.44	Yes	the experimenter	synthesized (.02, .04, .06, .07), time 2, 3
Cassidy et al. (2003) [11]	67	0.22	0.52	Yes	two female experimenters	synthesized (.09, .34)
Dockett & Degotardi (1997) [12]	24	0.46	0.54	Yes	the researcher	
Fink et al. (2014) [13]	114	0.30	0.49	Yes	the experimenter	synthesized (.35, .25), time 1, 2
Fink et al. (2015) [14]	114	0.35	0.49	Yes	interviewd individually	time 1
Flynn & Whiten (2012) [15]	88	0.34	0.58	Yes	the experimenter	
Hoglund et al. (2008) grade 2 [16]	114	0.15	0.50	Yes	the first author, research assistant helpers	
Kuhnert et al. (2017) [17]	114	0.12	0.49	Yes	interviewd individually	synthesized (.28, -.08), time 1, 2
Mizokawa & Koyasu (2011) [18]	102	0.19	0.55	Yes	the experimenter, the recorder	synthesized (.15, .32, .13, .15)
Morino (2005) junior class [19]	43	-0.06	0.51	Yes	the experimenter	
Morino (2005) middle class [19]	47	0.24	0.51	Yes	the experimenter	
Morino (2005) senior class [19]	47	0.40	0.49	Yes	the experimenter	
Peterson & Siegal (2002) [20]	109	0.32	0.40	Yes	the tester, the experimenter	synthesized (.31, .33)
Slaughter et al. (2002) study 1 [21]	78	0.27	0.47	Yes	a female experimenter	
Slaughter et al. (2002) study 2 [21]	87	0.11	0.47	Yes	a female experimenter	
Spence (1987) [22]	60	0.49	0.47	Yes	one of two research assistants	
Watson et al. (1999) study 2 [23]	52	0.41	0.42	Yes	the experimenter	

Discussion

Using data from 17 studies, this study found evidence for a disparity between interaction and non-interaction groups in studies of ToM and popularity.

The result seems to be open to interpretation. On the one hand, the result indicates that there seems to be a cue from the experimenter to obtain a wanted answer in traditional ToM studies. On the other, the result can lead to suggestion that tasks with non-interaction can underestimate children's real ToM abilities because real life is full of social cues and signals.

One limitation of this study is that the total number of included effect sizes was limited. Most studies included in this analysis had relatively small sample sizes. The results of this analysis should therefore be interpreted with some caution. In addition, like any meta-analysis, this study cannot account for unmeasured variables such as the personal characteristics of experimenters. Some experimenters can control their cues and others cannot. Unmeasured variables could have had an impact on this analysis.

This study highlights that interaction in experiments indicates overestimation in traditional study design. The result indicates that experimenters are, on average, likely to give children cues to answer properly. It seems that this problem is difficult to deal with, because this interaction is due to traditional ToM experiment design. Recommended methods to

overcome this problem can be ToM assessment by using audiocassette [4], computer [7, 8] or booklet [24].

Data availability

Supplementary materials can be found at <https://osf.io/82auq/>.

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