

**Supporting information – Research Review: The relationship between social anxiety and social cognition in children and adolescents: a systematic review and meta-analysis – by Pearcey *et al.***

**Appendix S1. Search criteria.**

**Search terms.**

***Social anxiety search terms:***

((anxi\* SAME social\*) OR (worr\* SAME social\*) OR (fear\* SAME social\*) OR (phobi\* SAME social\*) OR “social anxiety” OR “socially anxious” OR “Social anxiety disorder” OR “Social phobia” OR “socially phobic” OR shy\* OR (fear SAME negative\* SAME evaluat\*)) NOT (mouse OR mice OR rat OR chick\* OR sheep OR dog OR monkey\* OR animal\*).

***Autism Spectrum Disorder (ASD) terms (and relevant co-morbid conditions)<sup>1</sup>:***

(Autis\* OR Asperger\* OR ASD OR ASC OR PDD OR “autis\* spectrum disorder” OR “autis\* spectrum condition” OR “Asperger\* syndrome” OR “social communication disorder” OR “Pervasive developmental disorder” OR “Rett syndrome” OR “Fragile X” OR “Tuberous sclerosis”) NOT (mouse OR mice OR rat OR chick\* OR sheep OR dog OR monkey\* OR animal\*)

***Social cognition terms:***

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<sup>1</sup> Genetic disorders highly co-morbid with ASD (i.e. Rett Syndrome, Fragile X and Tuberous Sclerosis) were initially included, but were later excluded through screening as a diagnosis of these disorders does not require a deficit in social cognition, as in ASD.

("social cognit\*" OR mentali\$ing OR "theory of mind" OR "perspective taking" OR "belief tracking" OR "emotion\* expression" OR "emotion recognition" OR "emotion\* perception" OR "emotion\* processing" OR "emotion\* identification" OR "social knowledge" OR "affect recognition" OR "affect perception" OR "affect identification" OR "affect processing") NOT (mouse OR mice OR rat OR chick\* OR sheep OR dog OR monkey\* OR animal\*)

***Combination of search terms:***

(Social anxiety term AND autism spectrum disorder term) OR (Social anxiety term AND social cognition term)

**Additional search limits for each database:**

All databases included a limit of date, from 1980 – present.

***Web of Science***

- Databases: Core collection.
- Category:
  - Psychiatry, Psychology clinical, neurosciences, psychology developmental, psychology multidisciplinary, psychology, psychology social, psychology experimental, clinical neurology, behavioural sciences, paediatrics, psychology applied, psychology educational, social sciences interdisciplinary, psychology biological.
- Document types:

- Article, Review, proceedings paper, book chapter, meeting abstract, letter, book.
- Language: English.

### ***Psych Info***

- Databases:
  - All except: CAB abstracts, ICONDA and the philosopher's index.
- Limits: English language, English and humans (In
- Search tools (thesaurus):
  - Social skills (include “ability”, “social behaviour” and “social skills training”); combine with social communication terms with an OR)

### ***Medline***

- Limits: Humans.
- Proximity terms not applicable in this database.

### ***EMBASE***

- Limits: Human, English language.

### ***ERIC***

- Publication Type: Books, Collected Works (All), Dissertations/Theses (All), ERIC Publications, Information analyses, Journal Articles, Reference Materials (Bibliographies, general), Reports (All), tests/questionnaires.
- Language: English; Search modes - Boolean/Phrase

## **Appendix S2. Eligibility criteria.**

1. The full paper should be available in English.
2. The paper should present original data and not be a review (including systematic review, narrative review or meta-analysis, theory paper, letter/response to a paper).
3. The study should include a human child, adolescent or youth population. The ages of participant should be less than 21 years, with a mean age less than 18 years.
4. The sample should not be restricted in such a way that:
  - a. The full variance of either social anxiety or social communication are not represented.
    - i. For example, papers will be rejected if they include only a socially anxious or Autistic sample, or if they include only children that score above a cut off on questionnaire measures of either of these.
  - b. The restriction affects the association between social anxiety and social communication.
    - i. For example, if a sample is recruited from a population which is likely to affect scores on social anxiety or social communication (e.g. children with OCD or ADHD).
5. The study should include a standardised, age appropriate, trait or symptom/diagnostic measure of social anxiety completed by parent, child, teacher or independent observer should be included.

Social anxiety is defined as in Kashdan (2007) as “fear and avoidance of social situations in which a person might be exposed to negative evaluation by others.”

*This is to also include shyness, but does not include aspects related to (social) anxiety such as selective mutism or behavioural inhibition (which does not involve fear of negative evaluation).*

6. A measure of social cognition, defined as a measure of a child's ability (i.e. accuracy rather than a passive response) to identify and/or understand the thoughts, feelings and/or perceptions of another.

This may include a measure of:

- a. Identifying another's thoughts, intentions, beliefs, inferences and emotions/feelings.
- b. Understanding the above, as well as another's reactions, attributions and perceptions.
- c. Any other tasks that you feel meets the definition, code as unclear. (keep in mind that we are not including tasks that measure friendship quality, for example)

**NB:** Diagnostic measures may be included, where children are required to have a "deficit" in all areas in order to gain a diagnosis. However, questionnaire measures based on these diagnoses will not be included as a score on these measures does not imply a deficit in all areas. As a result, genetic disorders related to ASD will also not be included as these diagnoses are based on genetic assessments and not necessarily an assessment of the specific deficits in ASD.

7. Measures of social anxiety and social communication may be in the form of:

- a. A standardised questionnaire, where at least 60% of the items in the full scale or relevant subscale assesses one or other of constructs of interest as defined above
- b. A standardised clinical assessment (e.g. the ADIS, KSADS, ADOS, ADI-R), assessing one or other of constructs of interest as defined above, may be included.
- c. Observational measures may be included where children's behaviour relating to one or other of the constructs as defined above is coded using a standardised observation schedule.

"Standardised" is defined as a measure that can be applied consistently across the sample. For example, this would not include a peer nomination, where it is unclear by which parameters each peer is choosing their nomination.

- 8. The design of the study must allow for an effect size to be calculated for the relationship between social anxiety and social communication at baseline. Accepted designs may include:

- a. Quasi-experimental:
  - i. High anxiety group must be either clinically anxious (determined with diagnostic interview), score more than 1SD above normative mean on standardised social anxiety measure, or score above cut off recommended by author of measure.
  - ii. Same criteria also to apply to groups that are split based on social communication rather than anxiety.

- b.** Experimental (ie treatment trials for social based therapy) –
  - i.** Participants must be randomised into groups.
  - ii.** There must be a control group undergoing either wait list or alternative treatment (such as CBT).
  - iii.** Must measure both anxiety and social communication/ASD pre-treatment (and report relationship).
  - iv.** Must meet criteria for non-restricted group.
- c.** Correlations: Need to meet all previous criteria.

## **Appendix S3. Moderators and definitions.**

### **Conceptual Moderators**

- Social anxiety (as defined in appendix 2).
  - Social anxiety.
  - Shyness.
- Social cognition (as defined in appendix 2):
  - Autism Spectrum Disorders.
  - Emotion recognition.
    - Emotion recognition sub-type:
      - Accuracy (i.e. accuracy in naming an emotional expression)
      - Sensitivity (i.e. speed in naming an emotional expression)
    - Emotion recognition face type:
      - Adult, child, cartoon/drawing.
    - Emotion recognition face valence:
      - Happy, afraid, anger, disgusted, sad, combined score.
  - Theory of Mind (ToM)
    - False belief (i.e. the ability to identify and understand that others have different knowledge or beliefs as oneself)
    - Presentational display (i.e. identifying or understanding deceptive behaviours)
    - Affective ToM (i.e. understanding other's emotional responses)



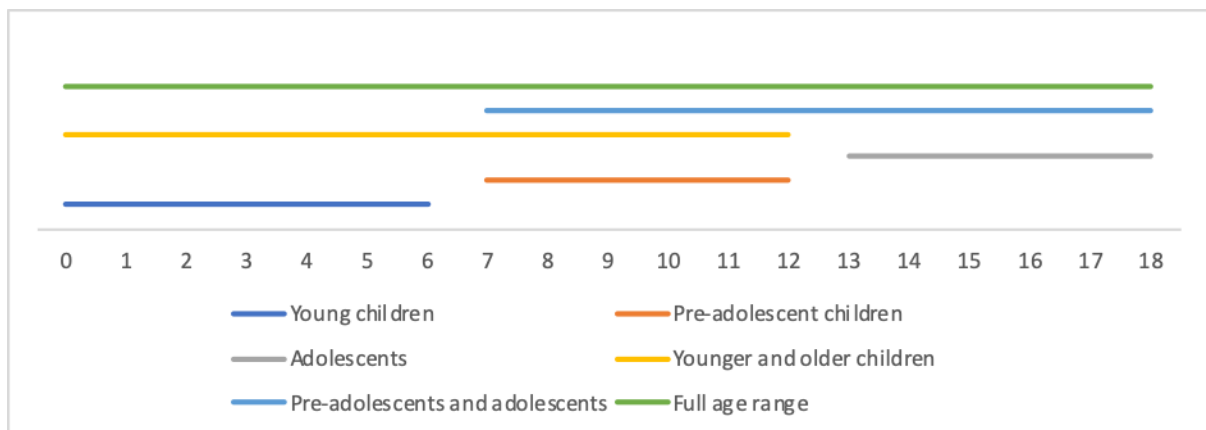
## **Methodological Factors**

- Study design:
  - Correlation.
  - Between groups.
- Sample type:
  - Community
  - Clinical
  - Mixed (i.e. clinical and community)
- Type of measure (for social anxiety and social cognition)
  - Clinical assessment.
  - Experimental task.
  - Interview.
  - Questionnaire.
- Informant of measure (for social anxiety and social cognition)
  - Self-report
  - Parent report
  - Teacher report
  - Clinician report

## **Demographic factors**

- Age group (see figure 1; based on age ranges that are conventional within the literature):
  - Young children – where all children in the sample were less than 6 years old (inclusive).

- Pre-adolescent children – Where all children in the sample were between 7-12 years old (inclusive)
  - Adolescents – Where all children in the sample were older than 13 years old (inclusive)
  - Younger and older children – where all children in the sample were younger than 12 years old (inclusive)
  - Pre-adolescents and adolescents – Where all children in the sample were older than 7 years old.
  - Full age range – Where the youngest participant in the sample is 6 years old or younger, and the oldest participant was 13 or older.
- Sex: Percentage of males in the sample.



**Figure S1.** The distribution of age ranges that studies were grouped into.

## **Appendix S4. Quality assessment.**

### **Scoring:**

**1:** “yes”, or that the paper satisfies the criteria.

**0:** “No”, or that the paper does not satisfy the criteria.

**CD:** Cannot determine (if it is not clear whether or not the paper satisfies the criteria)

**NA:** Not applicable (If that criteria is not applicable to the paper being reviewed)

**NR:** Not reported (If the authors have not reported the information required to determine whether or not they satisfied that criteria)

### **For all papers:**

#### **1. Was the research question or objective in this paper clearly stated?**

Did the authors describe their goal in conducting this research? Is it easy to understand what they were looking to find? This issue is important for any scientific paper of any type. High quality scientific research explicitly defines a research question.

#### **2. Was the study population clearly specified and defined?**

Did the authors describe the group of individuals from which the cases and controls were selected or recruited, while using demographics, location, and time period? If the investigators conducted this study again, would they know exactly who to recruit, from where, and from what time period?

#### **3. Did the authors include a sample size justification?**

Did the authors discuss their reasons for selecting or recruiting the number of individuals included? Did they discuss the statistical power of the study and provide a sample size calculation to ensure that the study is adequately powered to detect an association (if one

exists)? This question does not refer to a description of the manner in which different groups were included or excluded using the inclusion/exclusion criteria (e.g., "Final study size was 1,378 participants after exclusion of 461 patients with missing data" is not considered a sample size justification for the purposes of this question).

**4. Were the definitions, inclusion and exclusion criteria, algorithms or processes used to identify or select participants valid, reliable, and implemented consistently across all study participants?**

Were the inclusion and exclusion criteria developed prior to recruitment or selection of the study population? Were the same underlying criteria used for all of the groups involved? To answer this question, reviewers determined if the investigators developed I/E criteria prior to recruitment or selection of the study population and if they used the same underlying criteria for all groups. The investigators should have used the same selection criteria, except for study participants who had the disease or condition, which would be different for cases and controls by definition. Therefore, the investigators use the same age (or age range), sex, race, and other characteristics to select cases and controls. Information on this topic is usually found in a paper's section on the description of the study population.

**5. If less than 100% of eligible participants were selected for the study, were the cases randomly selected from those eligible?**

If a case-control study did not use 100 percent of eligible cases and/or controls (e.g., not all disease-free participants were included as controls), did the authors indicate that random sampling was used to select controls? When it is possible to identify the source population fairly explicitly (e.g., in a nested case-control study, or in a registry-based study), then random sampling of controls is preferred. When investigators used consecutive sampling,

which is frequently done for cases in prospective studies, then study participants are not considered randomly selected. In this case, the reviewers would answer "no" to Question 8. However, this would not be considered a fatal flaw.

If investigators included all eligible cases and controls as study participants, then reviewers marked "NA" in the tool. For between groups studies, if 100 percent of cases were included (e.g., NA for cases) but only 50 percent of eligible controls, then the response would be "yes" if the controls were randomly selected, and "no" if they were not. If this cannot be determined, the appropriate response is "CD."

**6. Were the measures of interest clearly defined, valid, reliable and implemented consistently (including the same time period) across all study participants?**

Were the measures defined in detail? Were the tools or methods used to measure exposure accurate and reliable—for example, have they been validated or are they objective? This is important, as it influences confidence in the reported exposures. For between groups studies, it is equally important whether the exposures were assessed in the same manner within groups and between groups. This question pertains to bias resulting from exposure misclassification (i.e., exposure ascertainment).

**7. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between dependant variables?**

Were key potential confounding variables measured and adjusted for, such as by statistical adjustment for baseline differences? Investigators often use logistic regression or other regression methods to account for the influence of variables not of interest.

**For between groups studies:**

**1. Were controls selected or recruited from the same or similar population that gave rise to the cases (including the same timeframe)?**

To determine whether cases and controls were recruited from the same population, one can ask hypothetically, "If a control was to develop the outcome of interest (the condition that was used to select cases), would that person have been eligible to become a case?"

Case-control studies begin with the selection of the cases (those with the outcome of interest, e.g., lung cancer) and controls (those in whom the outcome is absent). Cases and controls are then evaluated and categorized by their exposure status. For the lung cancer example, cases and controls were recruited from hospitals in a given region. One may reasonably assume that controls in the catchment area for the hospitals, or those already in the hospitals for a different reason, would attend those hospitals if they became a case; therefore, the controls are drawn from the same population as the cases. If the controls were recruited or selected from a different region (e.g., a State other than Texas) or time period (e.g., 1991-2000), then the cases and controls were recruited from different populations, and the answer to this question would be "no."

**2. Were the cases clearly defined and differentiated from controls?**

For this question, reviewers looked for descriptions of the validity of case and control definitions and processes or tools used to identify study participants as such. Was a specific description of "case" and "control" provided? Is there a discussion of the validity of the case and control definitions and the processes or tools used to identify study participants as such? They determined if the tools or methods were accurate, reliable, and objective.

**3. Use of concurrent controls?**

A concurrent control is a control selected at the time another person became a case, usually on the same day. This means that one or more controls are recruited or selected from the population without the outcome of interest at the time a case is diagnosed. Investigators can use this method in both prospective case-control studies and retrospective case-control studies.

**Table S1.** Sensitivity analyses omitting ASD studies.

	N Studies	k	r	95% CI	QM	p
<b>Overall</b>	32	119	-0.07 <sup>!</sup>	-0.14, -0.00		
<b>Conceptual Moderators.</b>						
Social cognition dimension/ phenotype.	31	118			0.03	0.87
Social anxiety dimension.	32	119			2.04	0.36
<b>Methodological Moderators.</b>						
Study design.	32	119			2.14	0.14
Sample type.	32	119			5.39	0.07
Type of social anxiety measure.	32	119			2.49	0.11
Type of social cognition measure.	31	118			0.41	0.82
Informant of social anxiety measure.	32	119			7.83	0.05 <sup>!</sup>
Informant of social cognition measure.	14	83			-	-
<i>Self-report.</i>	13	82	-	-		
<i>Parent report.</i>	1	1	-	-		
<i>Teacher report.</i>	1	1	-	-		
<i>Clinician report.</i>	0	0	-	-		
<b>Demographic factors:</b>						
Age group.	31	118			6.03	0.20
<i>Young children (&lt;= 6)</i>	11	27	0.03	-0.08, 0.13		
<i>Pre-adolescents (7-12)</i>	7	43	-0.12***	-0.18, -0.06		
<i>Adolescents (&gt;= 13)</i>	1	6	0.10**	0.04, 0.17		
<i>Younger &amp; older children (&lt;= 12).</i>	5	9	-0.09	-0.23, 0.06		
<i>Pre-adolescents &amp; adolescents (&gt;= 7)</i>	7	33	-0.11	-0.26, 0.05		
<i>Full age range (0-18)</i>	1	1	-	-		
Sex.	13	82			1.62	0.20

The first level under each moderator is the reference category.

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; <sup>!</sup> $p = 0.05$



**Table S2.** Sensitivity analyses omitting lower quality studies.

	N Studies	k	r	95% CI	QM	p
<b>Overall</b>	41	132	-0.16***	-0.24, -0.09		
<b>Conceptual Moderators.</b>						
Social cognition dimension/ phenotype.	41	132			14.23	0.00***
ASD	16	24	-0.30***	-0.46, -0.15		
Emotion recognition	12	81	-0.05	-0.14, 0.03		
ToM	16	27	-0.10***	-0.15, -0.05		
Social anxiety dimension.	41	132			1.04	0.60
<b>Methodological Moderators.</b>						
Study design.	41	132			6.00	0.01*
Correlation	18	64	-0.27***	-0.42, -0.13		
Between groups	24	68	-0.08**	-0.14, -0.02		
Sample type.	39	129			8.00	0.00**
Community.	22	64	-0.07**	-0.12, -0.02		
Clinical.	3	3	-	-		
Mixed	17	65	-0.28***	-0.42, -0.14		
Type of social anxiety measure.	41	132			1.26	0.26
Type of social cognition measure.	40	130			0.41	0.82
Clinical assessment.	16	24	-0.30***	-0.46, -0.15		
Experimental task.	21	90	-0.09**	-0.15, -0.03		
Interview.	4	16	-0.05	-0.16, 0.07		
Informant of social anxiety measure.	41	132			13.03	0.01*
Self-report	23	56	-0.17**	-0.28, -0.06		
Parent report	16	29	-0.22***	-0.33, -0.10		
Teacher report	3	11	-0.09	-0.28, 0.11		
Clinician report	5	36	-0.13	-0.31, 0.05		
Informant of social cognition measure.	41	132			11.48	0.00**
Self-report.	26	108	-0.08**	-0.13, -0.03		
Parent report.	4	5	-0.15	-0.36, 0.06		
Clinician report.	12	19	-0.35***	-0.55, -0.16		

**Demographic factors:**

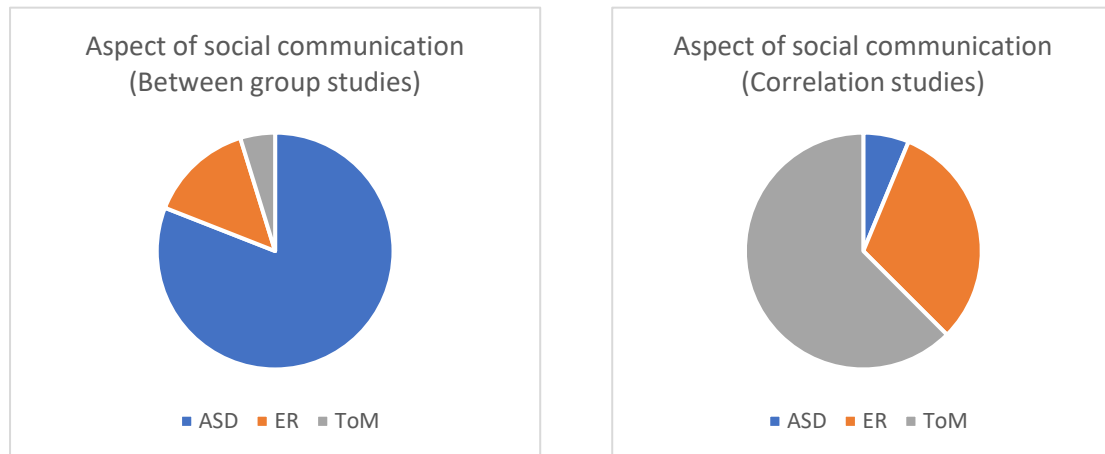
Age group.	39	129			7.94	0.09
<i>Young children (&lt;= 6)</i>	7	20	-0.08 <sup>!</sup>	-0.15, 0.00		
<i>Pre-adolescents (7-12)</i>	8	44	-0.12***	-0.17, -0.06		
<i>Adolescents (&gt;= 13)</i>	1	6	0.10***	0.04, 0.17		
<i>Younger &amp; older children (&lt;= 12).</i>	4	6	-0.04	-0.17, 0.10		
<i>Pre-adolescents &amp; adolescents (&gt;= 7)</i>	19	53	-0.27***	-0.41, -0.14		
<i>Full age range (0-18)</i>	2	3	-	-		
Sex.	39	127			0.24	0.63

The first level under each moderator is the reference category.

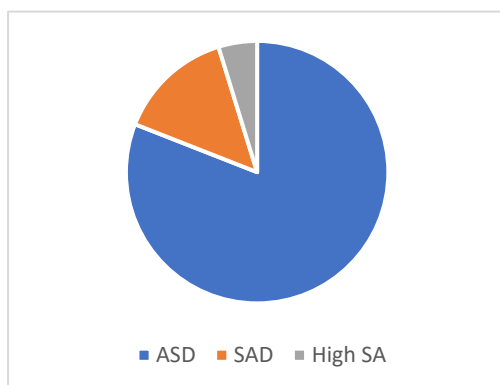
\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; <sup>!</sup> $p = 0.05$

**Figure S2.** Charts Illustrating the overlaps between moderators from the main findings.

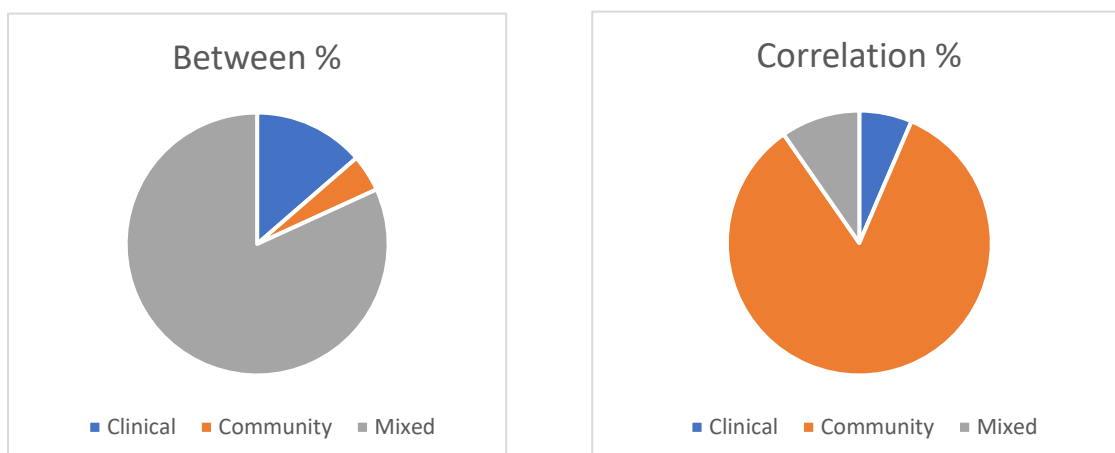
**Aspect of social communication within between group and correlation studies:**



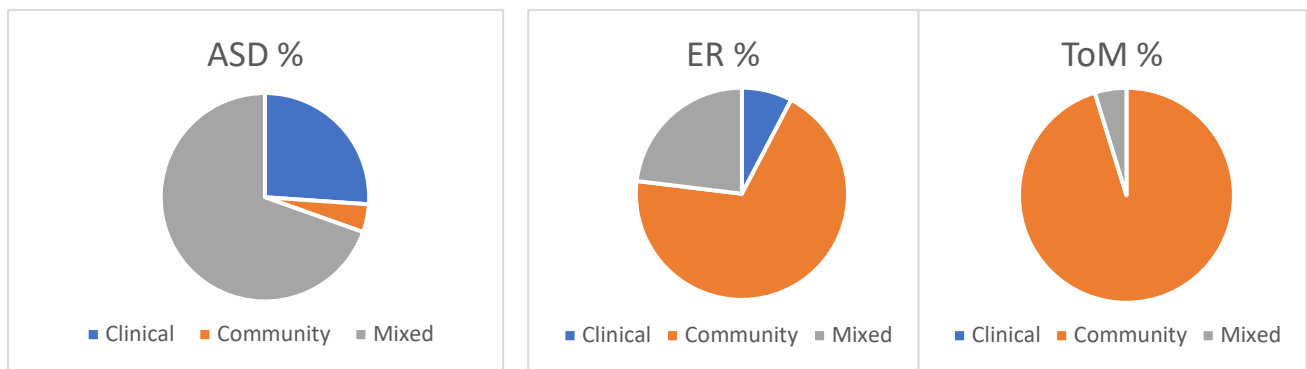
**Case groups in between group studies:**



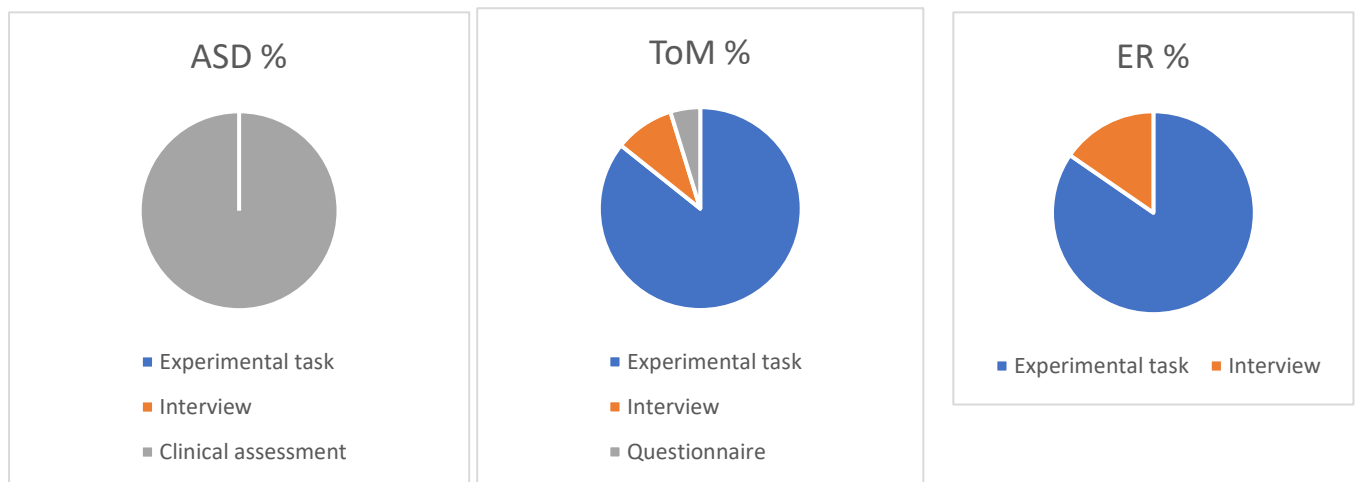
**Population studied in between group and correlation studies:**



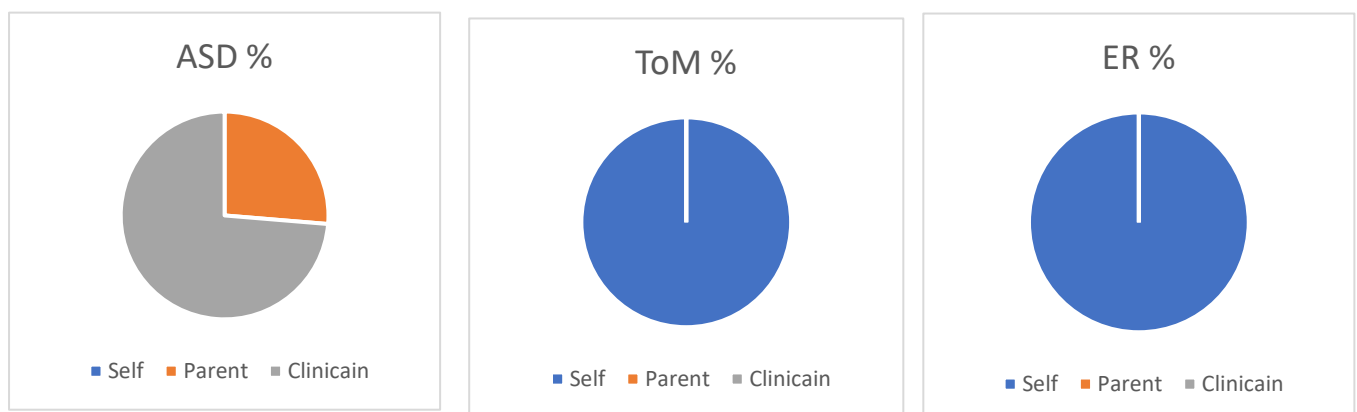
**Population studied within studies of each aspect of social cognition.**



**The type of social cognition measure used to assess each aspect of social cognition.**



**The informant of social cognition used to assess each aspect of social cognition.**



**The informant of social anxiety used to assess each aspect of social cognition.**

