Article:

Sills, J., Rowse, G. orcid.org/0000-0003-3292-4008 and Emerson, L.M. (2016) The role of collaboration in the cognitive development of young children: a systematic review. Child: Care, Health and Development, 42 (3). pp. 313-324. ISSN 0305-1862

https://doi.org/10.1111/cch.12330

The Role of Collaboration in the Cognitive Development of Young Children: A Systematic Review

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Short title: Collaboration and cognitive development

Abstract: 176

Body text: 5000

Figures: 0

Tables: 1

Keywords: Cognitive development, collaboration, problem-solving

Abstract

Background: Collaboration is a key facilitator of cognitive development in early childhood; knowing which factors influence cognitive development during collaborative exercises for young children has implications for educators and clinicians both in terms of academic outcomes and wellbeing. This review evaluates which factors mediate the impact of collaborative interactions on cognitive development in children aged 4-7 years.

Methods: A systematic search strategy identified relevant studies (n = 20), which assessed the role of ability on the relationship between collaboration and cognitive development. Other factors that interact with ability were also assessed: gender, sociability/friendship, discussion, age, feedback and structure.

Results: Immediate benefits of collaboration on cognitive development are highlighted for same-age peers. Collaborative interactions are beneficial for tasks measuring visual perception, problem-solving and rule-based thinking, but not for word-reading and spatial perspective-taking. Collaboration is particularly beneficial for low-ability children when there is an ability asymmetry. High-ability children either regressed or did not benefit.

Conclusions: Overall, the studies included within this review indicate that brief one-off interactions can have a significant, positive effect on short-term cognitive development in children of infant school age. The longer-term advantages of collaboration are still unclear. Implications for practice and future research are discussed.

Collaboration is a "coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem" (Rochelle & Teasley, 1995, p. 70). Small peer-based collaborative activities are used in schools to promote the development of verbal, cognitive and social skills (Gillies, 2006). Educational curricula emphasise that pupils should be able to actively engage in collaborative interactions, and consider and evaluate alternative viewpoints (Department for Education, 2013). This target requires children to develop a complex range of cognitive and social abilities during their first years in formal education.

Cognitive Development and Collaboration

The pioneering research of Doise, Mugny, and Perret-Clermont (1975) highlighted that collaborative interactions with peers has benefits for children's cognitive development; subsequent research has sought to understand the underpinning mechanisms. The two dominant paradigms are those of Piaget (1928, 1932) and Vygotsky (1978).

Piaget posited that 'disequilibrium', the discrepancy between information being presented and what is believed to be true (Piaget, 1928), is central to cognitive development. Peer interaction facilitates cognitive disequilibrium via socio-cognitive conflict; an external process where individuals are exposed to opinions different to their own (Piaget, 1959, 1977). Verbal exploration restores equilibrium and results in cognitive re-structuring. Piaget emphasised the role of equal peer relationships, whereas, Vygotsky argued that cognitive development was more likely to occur when individuals differed in their level of understanding (Duran & Gauvain, 1993). The child's *Zone of Proximal Development* (ZPD) determines the difference between what they could achieve independently and what they could achieve through collaboration with a more able partner (Vygotsky, 1978). A process *inter-subjectivity*, whereby individuals enter a collaborative interaction with different viewpoints, enables the development of a shared understanding (Cannella, 1993). Piaget and Vygotsky both emphasise collaboration as a mechanism through which cognitive development takes place. Both highlight the importance of verbal reasoning and discussion with another individual who has a different viewpoint, with the aim of achieving a shared understanding and consequent cognitive development (Tudge & Winterhoff, 1993).

A relevant alternative conceptualisation of cognitive development is Theory of Mind (ToM; Premack & Woodruff, 1978). ToM, the understanding that others have their own thoughts, feelings and beliefs, which might differ to your own, develops rapidly during early childhood (Baron-Cohen, 2001); Shared attention and information seeking are amongst the key cognitive and social processes required for ToM (Baldwin & Moses, 1996). Wimmer and Perner (1983) concluded that children under 3 years lacked ToM as they were unable to distinguish between what they and others knew. However, by 5 years, the majority of children understood that others might have different, sometimes false beliefs. By 6 years, normally developing children will have ToM (Perner & Wimmer, 1985), suggesting that children become less egocentric at a younger age than Piaget asserted. Collaborative interactions may facilitate the development of ToM, as children are exposed to conflicting views (Dunn, 1994). Alternatively, ToM might be necessary for effective collaboration; allowing the child to appreciate another viewpoint and consequently facilitating discussion and further cognitive development. Several studies have identified correlations between ToM and cognitive functioning tasks, independent of age and intelligence (Carlson & Moses, 2001; Hala, Hug, & Henderson, 2003). Both cognitive functioning and ToM develop rapidly between 4 and 7 years, and are central to school readiness (Blair, 2002; Capage & Watson, 2001; Riggs, Blair, & Greenberg, 2003).

A number of studies have evidenced a relationship between school success and social and emotional well-being (Elias & Haynes, 2008; Extremera & Fernández-Berrocal, 2004; Stipek & Miles, 2008). Primary schools are expected to facilitate the development of emotional well-being alongside academic achievement (HM Government, 2011). Therefore, knowing which factors influence cognitive development during collaborative exercises for young children has implications for educators and clinicians both in terms of academic outcomes and well-being. Consequently, the aim of this review is to consider which factors mediate the relationship between peer collaboration and cognitive development in children aged between 4 and 7 years.

Method

Search Strategy and Inclusion Criteria

A systematic search for articles published between January 1975 (following publication of Doise et al., 1975) and December 2013 was conducted of two major electronic databases (PsycINFO and Web of Science). The search was conducted between 28/12/13 and 16/01/14. Search terms from three key concepts were utilised: social interaction (collaboration, negotiation, interpersonal interaction, reciprocity, cooperation, cooperative learning, cooperative behaviour/behaviour, and cooperative play), cognitive functioning (cognitive development, cognitive ability, psychological development, problem-solving, cognitive hypothesis testing, critical thinking and decision making) and participant age (children, young people, childhood development, early childhood development, developmental stages, preschool students and child psychology). Reference lists of the articles identified from database searching were searched and forwards citation was undertaken using Google Scholar.

Studies fulfilling the following criteria were included: (1) included collaborative or cooperative task/s between peers; (2) non-clinical participants aged 4-7 years; (3) included cognitive functioning task/s completed pre- and post-interaction; (4) quantitative design and/or analysis; (5) published in English; and (6) peer reviewed.

Studies were excluded if they met any one of the following criteria: (1) included participants with mental health diagnoses or developmental disorders; (2) participants were outside of the specified age range; (3) non-peer reviewed e.g. conference presentations, dissertation abstracts and books; (4) position papers and reviews; (5) case studies; and (6) non-human participants.

The initial search identified 7772 articles. Titles and abstracts were screened for relevance and included if they referred to collaborative exercises with children. One hundred and sixty four articles were identified and abstracts reviewed in line with the inclusion and exclusion criteria. Full-text articles were accessed where necessary. Consequently 26 articles were identified as eligible for inclusion.

The methodological quality of the studies was assessed through an adapted version of the Downs and Black (1998) checklist. In line with previous reviews (MacLehose et al., 2000; Sohanpal, Hooper, Hames, Priebe, & Taylor, 2012), the checklist was modified to fit the aims of the current review. On item 27, a score of ‘1’ was given if a power calculation was reported. On item 25, a score of ‘1’ was given where age and/or gender was reported for each condition. Overall scores, out of 27, were classified as excellent (23-27), good (18-22), fair (14-19), and poor (less than 13).

The first author rated the full-text of each paper and an independent researcher rated three articles, selected as representative of a range in the quality. Overall agreement was 93%; discrepancies were resolved through discussion. Six papers classified as ‘poor’ quality were excluded. Twenty papers, classed as ‘fair’ quality, were included in the review (see Table 1).

[Insert Table 1 about here]

Results

Overview

The 20 studies included in this review had an aggregated number of 2140 participants, and sample sizes ranged from 32 to 264. The mean age of participants was 6.3 years (*SD* = .59) for those studies that reported this figure (*n* = 12), and 51.6% of participants were male (*n* = 15).

Most studies investigated more than one variable: the most frequently studied was ability of the child on a cognitive functioning task undertaken as the pre-test (*n* = 16), followed by individual versus collaborative working on the task (*n* = 7) and gender (*n* = 6). Sociability/friendship, discussion during the task, age, feedback and structure were also considered. The articles are organised and discussed in accordance with their primary aim in order to avoid repetition. All but one study used a mixed-factorial design: Cannella, Viruru, and Amin (1995) used a within-subjects design. All studies involved a pre-test, interaction phase (collaborative task) and post-test. Half (*n* = 10) included a control group; typically, participants worked on the same task independently. Interaction tasks were predominantly the same as the pre-post tasks. The median number of interaction sessions was one, with a range of 1-32. The timeframe for completing post-task measures varied from immediately after the interaction to seven weeks later.

The mean quality rating score was 15 (*SD* = .91). Internal validity (71.4%) was relatively high as were levels of reporting (66.5%). Lowest scores were on the internal validity confounding (35.7%) and external validity subscales (36.7%). No studies reported a calculation of statistical power in reference to sample size.

Individual versus Collaborative Working

Four studies reported a significant advantage of peer collaboration over individual working on post-test measures of planning, reasoning, visual discrimination/perception, problem-solving, and rule-based thinking (Fawcett & Garton, 2005; Gabbert, Johnson, & Johnson, 1986; Gillies & Ashman, 1998; Tudge, 1989). In support of these findings, Tudge and Winterhoff (1993) reported that the improvement of those collaborating with a partner on a mathematical balance beam task was significantly greater than zero. However, this study did not use a control group so it is unclear whether there would have been a similar improvement for those working independently on the task.

Three studies measured language development. Gillies and Ashman (1998) reported significantly more cognitive language use by those in a collaborative condition and Gómez et al. (2013) reported a large effect size of working collaboratively on a measure of oral language. Gómez et al. (2013) also reported an improvement in social skills for those who had collaborated (medium effect size), compared to deterioration in the 'curriculum-as-usual' control group. Those who had collaborated during an interactive task used higher reasoning strategies than those who had worked independently (Gabbert et al., 1986). The majority of these studies were rated as average quality due to a poor data reporting.

Three studies reported non-significant differences between collaborative and individual conditions on spatial perspective-taking (Bearison, Magzamen, & Filardo, 1986); word reading (Gillies & Ashman, 1998); and arithmetic (Gabbert et al., 1986). Two of these studies were rated as the highest quality of those included within this review, adding weight to their findings.

Gender

The role of gender in cognitive development was examined using spatial perspective tasks (Bearison et al., 1986; Cannella, 1992). In a comparison of same-gender dyads, Bearison et al. (1986) reported that type of conflict differed significantly between the groups: females engaged in more *enactive disagreements* (physically corrected their partner), whereas males engaged in more *verbal disagreements with explanation*. Within an optimal range, verbal disagreements with explanation were significantly associated with cognitive development, but only for male dyads. Bearison et al. was rated as one of the highest quality studies in this review; however, it did not include different gender dyads. Cannella (1992) extended the findings from Bearison et al. by comparing same and mixed-gender dyads; in same-gender pairings, males made significantly more cognitive gains than females. Taken together, the findings from these studies suggest that the relationship between cognitive development and collaboration might be stronger in male dyads. Although these studies were rated as relatively high quality, neither controlled for differences in ability within the dyads.

Ability

The majority of studies in this review varied the ability within the collaboration-dyads and used Piagetian measures of egocentricity and conservation, or non-Piagetian measures of cognitive functioning. Based on pre-test scores, participants were classed as high- or low-ability. Consistently across studies, low-ability participants benefitted most from collaborating with a high-ability peer, compared to low-ability participants who worked on the task independently.

The conservation of liquid task was used in three studies (Psaltis, 2011; Psaltis & Duveen, 2006, 2007). Psaltis (2011) reported that low-ability participants in mixed-ability dyads performed significantly better on an immediate post-task compared to those of low-ability who worked independently. Psaltis and Duveen (2006) confirmed this advantage one month after the interaction phase, indicating stability in the findings. However, Psaltis also included a delayed post-test conducted seven weeks post-interaction and reported that the advantage for low-ability participants was not maintained. The lack of significance between the conditions at this point was attributed to the high rate of progress made by the control group, suggesting that working collaboratively increases cognitive benefits in the short-term for low-ability participants, but this advantage might not be significant in the longer term. Psaltis' study included two control groups: both completed the pre-task but then one control group completed the immediate post-task, whilst the second control group completed the delayed post-task. Even though random assignment took place, there is no report of possible differences between the control groups at pre-test. Therefore, the lack of significant difference at delayed follow-up should be interpreted with caution.

Several studies utilised non-Piagetian measures of cognitive functioning, including sorting ability (Fawcett & Garton, 2005; Garton & Pratt, 2001); rule-based thinking (Tudge, 1989; Tudge & Winterhoff, 1993); spatial perspective-taking (Azmitia, 1988; Da Silva & Winnykamen, 1998); and cognitive reasoning (Gabbert et al., 1986). Post-test length varied from immediately after the collaborative interaction to four weeks later. All studies demonstrated that low-ability children paired with same-age high-ability children, either within a dyad or a small group setting, improved significantly post-test, compared to same-ability pairings and/or control groups where individuals did not participate in the collaborative interaction.

Cannella (1993) argued that rather than ability asymmetry, it is more important for participants to engage in a *shared cognitive experience,* where their concerns are acknowledged and responded to. In relation to low-ability participants, Psaltis and Duveen (2006, 2007) identified two key types of conversation that were related to cognitive growth: *explicit recognition,* where the low-ability child verbally indicates that they have changed their understanding of the task; and *resistance,* where the low-ability child initially defends their position before accepting the view of the high-ability child. Nearly all of the participants that engaged in explicit recognition conversations improved post-test, and half of the low-ability students who had engaged in this type of conversation made use of novel arguments in their post-test (Psaltis & Duveen, 2006). The authors posited that explicit recognition and resistance conversations facilitate socio-cognitive conflict and consequent cognitive development through active participation in the collaborative exercise. This finding was in contrast to *compliance* conversations, where the low-ability participant passively accepted the high-ability student's views.

Cannella (1993) reported no significant difference in cognitive development between dyads of same- and mixed-ability. However, a greater percentage of the mixed-ability dyads improved compared to the same-ability dyads (58% and 33% respectively). The authors did not report a power calculation, so the study might have been insufficiently powered to detect a significant effect. Furthermore, although this study was of relatively high quality, there was no control group or longer-term follow up.

Fawcett and Garton (2005) identified a trend towards regression for high-ability participants when collaborating in a mixed-ability dyad, in that their scores were lower on the post-test. The only exception to this was in the condition where ability was mixed and discussion during the interaction phase was encouraged. A lower quality study also highlighted regression on post-test scores for high-ability partners within mixed-ability dyads (Tudge, 1989).

A number of studies explored the interaction between ability and factors such as gender, opportunity for discussion, age, feedback, friendship and sociability.

Gender

Several studies investigated the relationship between gender, ability and cognitive development using spatial perspective-taking or conservation tasks. A consistent finding confirmed an advantage for male novices paired with female experts: these males progressed more on an immediate post-test compared to novices who worked independently (Psaltis & Duveen, 2006, 2007) or novices in same-gender pair types (Zapiti & Psaltis, 2012). However, there was no advantage over working independently for female novices paired with a male expert.

Psaltis and Duveen (2007) reported that female experts were twice as likely to concede to the view of novices as were male experts. However, novices who interacted with a female expert used significantly more novel arguments during the post-test than those who had interacted with a male expert (Psaltis & Duveen, 2006). Therefore, being paired with a high-ability female is beneficial for the novice regardless of gender, but this interaction might be detrimental to the cognitive development of the female expert.

Psaltis (2011) reported somewhat contradictory findings. male and mixed-gender dyads of mixed-ability in the interaction condition scored significantly higher on post-test spatial perspective-taking than those in the control group: there were no significant differences between female dyads who collaborated and those who worked independently. However, on a task classed as more complex, only the female dyads from the interaction condition scored significantly higher than the control group. The authors fail to explain why the mixed-ability female dyad performed differently to the other dyads on these tasks. This study was rated as amongst the highest quality in this review, but this finding was not reported in any other study, so should be interpreted with caution.

Opportunity for discussion

The role of discussion was explored in two studies (Fawcett & Garton, 2005; Pine & Messer, 1998). Pairs or small groups of similar or mixed-ability participants were randomly allocated to either a discussion or control condition (independent working, Fawcett & Garton; no discussion, Pine & Messer). Discussion participants improved significantly more than controls on a card-sorting task (Fawcett & Garton) and a balance beam task measuring rule-based thinking (Pine & Messer). Discussion was mostly helpful to low-ability students and those working in a mixed rather than a same-ability group (Pine & Messer).

Age

Duran and Gauvain (1993) investigated the relationship between ability and age on planning and sequencing. Based on pre-test scores, participants aged 5 or 7 years were classed as ‘novice’ or ‘expert’. All dyads were mixed-ability; the age of the expert (same or older) varied. Novices who collaborated with same-age experts performed significantly better than novices who did not collaborate. However, this finding was not significant when a younger novice collaborated with an older expert. Increased involvement by the novice in the collaborative task was associated with more effective planning in the post-test: conversely, increased expert involvement was related to less effective post-test planning by the novice.

Feedback

Tudge and Winterhoff (1993) provided half of the same and mixed-ability dyads with feedback during the interaction session. Those who received feedback improved significantly more than those who didn’t, regardless of the type of partner and ability composition. These effects were evident immediately and maintained one month later, highlighting the importance of feedback in supporting cognitive development and suggests that feedback might mediate the advantage of ability asymmetry.

Friendship and sociability

Fraysse (1994) tested the role of friendship and ability through a test of conservation. All dyads were mixed-ability but varied on the basis of friendship: self-selecting '*mutual friends*'; '*unilateral associate's* where only one had chosen the other; and *'negative associates'* where neither had selected the other. Mutual friends showed the greatest improvement post-collaboration, worked together for longer and had the highest number of positive exchanges. Unilateral associates, where the low-ability student had picked a high-ability student, had the next greatest amount of improvement on both a test of conservation and of generalisation.

Similarly, Da Silva and Winnykamen (1998) considered the impact of sociability and ability on a task of problem-solving. Children were matched for sociability (high/low), as rated from responses by other participants. Dyads were either the same- or mixed-ability. High-sociable children, regardless of ability, improved significantly more post-test and demonstrated greater cooperation, than low-sociable children. Low-ability, high-sociable children progressed significantly more when in mixed-ability dyads: this dyad formation was not significant for low-sociable children.

Only two studies of relatively low quality have explored the impact of friendship and sociability on cognitive development, therefore caution needs to be taken when drawing conclusions. However, these important variables of interest could be investigated in future research with a stronger methodological framework.

Structure

Gillies and Ashman (1998) randomised small mixed-ability groups to a structured or unstructured condition. The structured condition received two training sessions, which explicitly taught small group procedures and interpersonal behaviours to promote group collaboration. Following this, both conditions participated in small group activities over a period of six weeks. Post-interaction analysis confirmed that the structured groups used more cognitive and higher level language strategies. However, there was no significant difference between the groups on a test of word-reading, a generalised of the cognitive skills directly involved in the group activities. Limited conclusions can be drawn as only one study measured the impact of structure; however, this study was rated as one of the highest quality, providing some legitimacy to the suggestion that structure encouraged cognitive development directly related to the group activities, but this benefit did not generalise to other components of cognitive development.

Discussion

This review aimed to explore which factors affect the relationship between collaboration and cognitive development in children aged 4 to 7 years. In all studies, participants engaged in collaborative tasks, which supports the ToM literature, as children become less egocentric at an earlier age than Piaget's (1952) stage theory predicted. Positive effects of collaborative-working, compared to individual-working, were reported on a range of cognitive measures, including visual discrimination, visual perception and problem-solving. Higher quality studies reported benefits of collaborative-working on card-sorting, language ability and rule-based thinking tasks. However, several higher quality studies reported no significant differences between collaborative and individual conditions on measures of word-reading and spatial perspective-taking. Therefore, collaboration does not appear to be beneficial across all components of cognitive functioning. This difference in benefit may be due to variation in task difficulty; collaboration might be more beneficial on complex cognitive tasks (Gabbert et al., 1986). Based on the studies reviewed, ability and gender have the greatest impact on collaboration and cognitive development.

In line with Vygotsky's theory, a consistent finding was that, compared to independent working, collaboration led to short-term cognitive benefits for low-ability children who were paired with a high-ability peer. Several high-quality studies reported improvements on sorting ability, conservation and spatial perspective-taking. The socio-cognitive conflict and disequilibrium caused by being paired with someone with a different view on the task seems to have facilitated cognitive development. This process requires active participation through discussion and reasoning. Discussion seems to be most helpful for low-ability children, highlighting the importance of different opinions being verbalised, to allow socio-cognitive conflict to become apparent and resolved.

Several studies identified the factors that interact with ability: gender, age, discussion and feedback. These studies identified conditions that provide an advantage to low-ability participants. For low-ability males, the greatest amount of discussion and cognitive development was seen when they were paired with a high-ability female. However, for low-ability females, being paired with a high-ability male had no additional benefit to working independently. These findings can be understood in the context of power imbalances within the collaborative dyad. With regards to gender roles in society, it could be argued that as males hold more power, the pairing of high-ability females with low-ability males is more equal due to the female holding more power in terms of knowledge. When the female is classed as low-ability, the male has an advantage both in terms of power and ability, reducing the benefits of collaboration for the female (Psaltis & Duveen, 2006). This explanation is supported by the findings regarding age; when there was too great a power imbalance (expert older child), the novice did not progress cognitively. Therefore, Vygotsky's assertion that ability asymmetry is important for cognitive development to occur is supported, as well as Piaget's assertion that it is unhelpful for there to be too great a power imbalance within the dyad. The majority of these studies were rated towards the lower end of the quality rating scale due to limitations in the reporting of the data (Psaltis & Duveen, 2006, 2007; Zapiti & Psaltis, 2012). Furthermore, all of these studies involved the same author and utilised Greek-Cypriot populations, so it is unclear whether this effect would be replicated in other countries and cultures.

A common finding was that high-ability participants did not benefit as much or at all from collaborating with a low-ability peer. Low-ability children may require external input to provide the socio-cognitive conflict needed for cognitive re-structuring to occur. For high-ability children, the process of further development might be more internal, negating the need for collaboration and socio-cognitive conflict (Pine & Messer, 1998). A few studies highlighted regression for high-ability participants, which could represent an artefact of the tests, but could warrant further investigation. Although low-ability participants demonstrated incorrect reasoning, they could be more certain in their views due to the consistency with which they could apply this reasoning to the task. High-ability participants could be uncertain about their reasoning, so trading accuracy for certainty (Tudge, 1989).

Several methodological limitations were identified across the literature, with no study achieving higher than ‘fair’ quality. Although the checklist was designed for health interventions, the studies reviewed consistently failed to meet certain relevant methodological criteria. Recruitment details were often omitted (e.g. recruitment method and rate), so selection bias may be a factor. Many of the studies used the same measure for the pre-test, interaction phase and post-test, which is useful for measuring change over time on one area of cognitive functioning, but poses a potential issue around practice effects. Only a few studies investigated whether the benefits of collaboration generalised to other areas of cognitive development. Furthermore, no studies explored the impact on cognitive development of engaging in non-cognitive collaborative exercises in the interaction phase. Only three studies included delayed post-tests, so firm conclusions about maintenance and incubation effects of collaboration cannot be drawn.

There were several limitations of the methodology used in this review. This review focused on studies of children aged 4-7 years; therefore, effects for older children are not considered. We are also unable to comment on whether the same factors remain as important in the longer-term. Only articles available in English language were included, which might have led to bias in study selection.

Practice implications

The results from this review have implications for the fields of education, health and care. Within any classroom there will be a range of additional needs, including developmental disorders, learning disabilities and mental health difficulties. In particular, children with Autism Spectrum Disorder (ASD) or attachment difficulties are likely to find it more challenging to build peer relationships and might have ToM difficulties (Stokke, 2011). Therefore, it is likely that they might experience difficulties collaborating with peers. These difficulties can be understood in the context of ZPD: children with social skills deficits will find it more challenging to understand subtle social cues within peer relationships, thus might find it harder to identify and work within their partner's ZPD. Furthermore, children with attachment difficulties might demonstrate controlling or passive engagement styles, both of which are likely to disrupt the collaborative interaction, impacting on their cognitive development and well-being. Professionals working in child services are well placed to understand the complexity of these difficulties and provide appropriate interventions to support the development of social skills and collaborative working within school settings. Furthermore, providing teaching and training to educators around the impact of ASD and/or attachment difficulties on a child's ability to collaborate could draw attention to this issue and provide opportunities for discussion around the best way to holistically meet their social, emotional and academic needs.

This review highlights the role of friendships and sociability in collaboration and cognitive development. This is a potential area of difficulty for children with additional developmental needs, including problems with attunement, ToM, and engaging in reasoning and negotiation. If both partners within a dyad are not very sociable, it is likely that the collaborative interaction will fail, with each participant focused on their individual needs rather than those of the dyad. In order to facilitate positive collaborative interactions for this sub-group, it is likely to be advantageous to pair them with someone that they identify as a friend. Thinking Actively in a Social Context (TASC; Wallace, Bernadelli, Molyneux, & Farrell, 2012) is an educational framework to stimulate thinking and problem-solving. Based on Vygotsky's principle of ZPD, small groups of mixed-ability children work creatively and collaboratively on a task. This review indicates key aspects of group composition to consider when utilising the TASC approach and may be an existing structure where positive collaborations can be facilitated.

It is important to acknowledge that it is not always going to be possible to match students based on all of the variables considered within this review at any one time. Nor is it going to be feasible to meet the individual needs of all of the children in the class in every collaborative interaction. Therefore, a range of experiences should be provided, including opportunities for individual and collaborative working, with a range of peers with mixed abilities, with opportunities for discussion and feedback. In this way, all children's needs and strengths can be considered.

Future research

The methods for testing cognitive functioning have developed since many of the reviewed studies were undertaken; it would be interesting to move away from Piagetian measures and explore the short and long-term impact of collaboration on measures of executive functioning, such as attention, inhibition and cognitive flexibility. The impact of having an ability differential within a collaborative interaction has been explored, but has largely neglected the potential benefits and drawbacks for high-ability students. Future research could investigate this further. The roles of gender, feedback, structure, discussion and age merit further research in this age group due to the limited number of studies investigating these variables.

Conclusions

"What the child can do in cooperation today, he can do alone tomorrow" (Vygotsky, 1962, p.104). Overall, the studies included within this review indicate that brief one-off interactions can have a significant, positive effect on short-term cognitive development in children of infant school age, particularly for low-ability children, above and beyond what would be expected from working on the same task independently.

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Table 1

Characteristics of studies included in review

Authors	n	Age (years)	Interactive session	Control group	Independent variable(s)	Dependent variable(s)	Main findings	Quality rating
Azmitia (1988)	132	5	Building task	No	Ability	Spatial perspective Visual perception	Mixed ability dyads performed better than same ability dyads or individuals.	15
Bearison, Magzamen, and Filardo (1986)	106	5-7	Model replication	Yes	Individual/ Collaborative Gender	Spatial perspective	No significant difference between individual and collaborative conditions. Gender differences in types of disagreements: females more likely to physically correct their partner, males more likely to verbally disagree. The latter within an optimal range was significantly associated with cognitive development.	17
Cannella (1992)	66	5-7	Spatial awareness task	No	Gender	Spatial perspective	Male same-gender pairings made significantly greater cognitive gains than female same-gender dyads.	16
Cannella (1993)	66	5-6	Spatial awareness task	No	Ability	Spatial perspective	No significant difference between same ability and different ability dyads. However, a higher proportion of different ability dyads improved.	16
Cannella, Viruru, and Amin (1995)	56	5-6	Spatial and literacy tasks	No	Ability	Spatial perspective Literacy	Gender of individual or partner did not affect extent of cognitive development.	14
Da Silva and Winnykamen (1998)	80	6-7	Spatial awareness task	No	Sociability Ability	Spatial perspective Cooperative behaviours	Sociable children improved significantly more on the cognitive task. Low ability sociable children progressed significantly more in mixed ability dyads. This was not significant for non-sociable children.	14
Duran and	70	5, 7	Sequencing	No	Ability	Sequencing	Novices paired with same-age experts improved	15

Authors	n	Age (years)	Interactive session	Control group	Independent variable(s)	Dependent variable(s)	Main findings	Quality rating
Gauvain (1993)			task		Age		significantly more than those who worked individually. This was not found when the expert was older. Increased novice involvement was significantly related to effective planning. Increased expert involvement was significantly related to less effective planning.	
Fawcett and Garton (2005)	100	6-7	Card sorting	Yes	Individual/ Collaborative Ability Discussion	Card sorting	Those who collaborated scored significantly higher than those who worked individually. Only low ability children working with a high ability peer improved significantly. There was a trend towards regression for higher ability participants. Discussion condition improved significantly compared to no discussion.	16
Fraysse (1994)	76	6-7	Conserva-tion task	No	Friendship Ability	Conservation	Friendship peers progressed significantly more than non-friends and worked together for longer. On a generalisation task, the dyad where the low ability student had selected the high ability student scored the highest.	14
Gabbert, Johnson, and Johnson (1986)	52	6-7	Problem-solving	Yes	Individual/ Collaborative Ability	Problem-solving Visual discrimination Visual perception Memory Arithmetic	Those who collaborated scored significantly higher compared to those who worked individually on measures of problem-solving, visual discrimination/ perception and memory. There were no significant differences in arithmetic.	15
Garton and Pratt (2001)	222	4, 7	Card sorting	Yes	Individual/ Collaborative Ability	Card sorting	Lower ability children in mixed ability dyads improved significantly more than same ability dyads and those who worked individually.	15

Authors	n	Age (years)	Interactive session	Control group	Independent variable(s)	Dependent variable(s)	Main findings	Quality rating
Gillies and Ashman (1998)	152	6-7	Problem-solving	Yes	Individual/ Collaborative Structure	Cognitive language and reasoning Word reading	Those who collaborated scored significantly higher than to those who worked individually in their use of cognitive language and higher levels of cognitive reasoning. There were no differences on a word reading test.	17
Gómez *et al.* (2013)	232	5-6	Matching, sorting and role playing	Yes	Individual/ Collaborative	Oral language Social skills	The collaborative condition improved more than the control group in oral language skills. The collaborative condition demonstrated improved social skills, whereas the control group worsened.	15
Pine and Messer (1998)	103	5-7	Balance beam task	Yes	Ability Discussion	Rule-based thinking	The discussion condition improved significantly more than the no discussion condition. Discussion was of greatest benefit to low ability participants in mixed ability groups.	15
Psaltis and Duveen (2006)	226	6-7	Conserva-tion task	Yes	Gender Ability	Conservation	Non-conservers who collaborated made significantly more progress than non-conservers who worked individually. Resistance and explicit recognition conversations were most important for cognitive development. It was advantageous for male novices to be paired with a female expert, but disadvantageous for female novices to be paired with a male expert.	14
Psaltis and Duveen (2007)	226	6-7	Conserva-tion task	Yes	Gender Ability	Conservation	Female conservers were twice as likely to concede to non-conservers as male conservers. Female novices in mixed gender dyads were most likely to engage in resistance conversations.	15
Psaltis (2011)	264	6-7	Conserva-tion task	Yes	Gender Ability	Conservation	Low ability participants in mixed ability dyads progressed significantly more compared to low ability participants working individually. Dyads where a male novice was paired with a female expert showed the most progress.	16

Authors	n	Age (years)	Interactive session	Control group	Independent variable(s)	Dependent variable(s)	Main findings	Quality rating
Tudge (1989)	84	5-7	Balance beam task	Yes	Individual/ Collaborative Ability	Rule-based thinking	Participants who worked collaboratively improved significantly compared to those working individually. High ability participants regressed after collaborating in mixed ability dyads.	15
Tudge and Winterhoff (1993)	81	5-6	Balance beam task	No	Individual/ Collaborative Ability Feedback	Rule-based thinking	Collaborating with a more advanced peer was more advantageous than working alone or working with an equally competent partner. When feedback was provided, this difference was no longer significant.	16
Zapiti and Psaltis (2012)	159	6-7	Spatial awareness task	No	Gender Ability	Spatial perspective	It was advantageous for a male novice to be paired with a female expert, but disadvantageous for female novices to be paired with a male expert.	15

Key messages:

- Immediate benefits of collaboration on cognitive development are highlighted for same-age peers. Collaborative interactions are beneficial for tasks measuring visual perception, problem-solving and rule-based thinking, but not for word-reading and spatial perspective-taking.
- Collaboration is particularly beneficial for low-ability children when there is an ability asymmetry. High-ability children either regressed or did not benefit.
- A range of collaborative experiences should be provided in education, including opportunities for individual and collaborative working, with a range of peers with mixed abilities, with opportunities for discussion and feedback.
- Future research should utilise modern measures of executive function, attention and memory.
- The potential benefits and drawbacks for high-ability students should be further explored.