Early Oral Language Comprehension, Task Orientation, and Foundational Reading Skills as Predictors of Grade 3 Reading Comprehension

eTale 2022

The present five-year longitudinal study focused on children from pre-school to Grade 3. The developmental associations among oral language comprehension, task orientation, reading precursors, and reading fluency were examined, together with their role in predicting Grade 3 reading comprehension. Oral language comprehension, reading fluency, and task orientation each contributed uniquely to concurrent reading comprehension. Further, a reciprocal relationship was found between oral language comprehension and task orientation.

Authors: Janne Lepola, Julie Lynch, Noona Kiuru, Eero Laakkonen, & Pekka Niemi

Source: Lepola, J., Lynch, J., Kiuru, N., Laakkonen, E., & Niemi, P. (2016). Early oral language comprehension, task orientation, and foundational reading skills as predictors of Grade 3 reading comprehension. *Reading Research Quarterly, 51*(4), 373-390, doi: 10.1002/rrq.145

The present five-year longitudinal study focused on children from pre-school to Grade 3. The developmental associations among oral language comprehension, task orientation, reading precursors, and reading fluency were examined, in addition to their role in predicting Grade 3 reading comprehension. Oral language comprehension and task orientation were assessed from 90 Finnish-speaking students in pre-school, kindergarten, and Grade 3. Reading precursors were assessed at the first two timepoints and reading fluency at the third. Oral language comprehension, reading fluency, and task orientation each contributed uniquely to concurrent reading comprehension. Moreover, a reciprocal relationship was found between oral language comprehension and task orientation.

- Reading comprehension is based on two basic components: word decoding and oral language skills.
- Whereas skills such as phonological awareness and letter identification allow young readers to decode individual words, oral language skills (such as vocabulary and narrative comprehension) lay the foundation for deciphering meaning from text.
- When a reader constructs a coherent mental representation of a narrative, a number of cognitive skills are employed at the word, sentence, and text levels. These skills include activation of word meanings, understanding sentences, making inferences, monitoring comprehension, and understanding text structure.
- Children start to understand complex narratives from the age of 4 years.

What is task orientation?

- Task orientation is an umbrella term for a child's tendency to accept challenging aspects of a learning task, which is observed as approaching, exploring, and mastering behaviours.
- Task orientation incorporates the pursuit of task-

intrinsic goals (goals), such as gaining task-related understanding and sense of competence (self-efficacy).
- Concentration on the task at hand, positive emotional expressions that are related to the task (attitude), and persistence (agency) exemplify task orientations.
- At least a moderate expectation of success is inherent in task-oriented behaviours.

The study

The present five-year study had two aims:

1. The longitudinal and concurrent roles of task orientation, oral language comprehension, reading precursors, and reading fluency in the prediction of reading comprehension in Grade 3 were examined.
2. It was investigated whether oral language comprehension, reading precursors, and task orientation follow independent pathways or are reciprocally related to each other from preschool to Grade 3.

Participants

The study included 90 Finnish-speaking children, who were followed from age 4 years (preschool), to age 6 years (kindergarten), and to age 9–10 years (Grade 3). At Time 1 (age 4 years) and Time 2 (age 6 years), letter knowledge, phonological awareness, vocabulary, listening comprehension, and inference making were assessed. At Time 3 (Grade 3), listening comprehension, inference making, text-reading speed and accuracy, and reading comprehension were assessed. Task orientation was assessed by preschool, kindergarten, and Grade

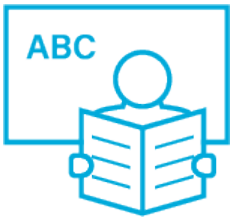
3 teachers.

Findings

- Vocabulary knowledge at Time 1 was more strongly associated with concurrent listening comprehension than with letter knowledge or phonological awareness.
- The association between letter knowledge and phonological awareness was modest at age 4 years (r = 0.29), but strong at age 6 years (r = 0.62).
- Inference making was more strongly associated with vocabulary and listening comprehension than with letter knowledge.
- The stability of reading precursors from preschool to kindergarten and the stability of oral language comprehension from preschool through kindergarten to Grade 3 are evident from the data.
- The stability of task orientation was high from preschool to kindergarten (0.75), but lower from kindergarten to Grade 3 (0.40).
- In preschool, oral language comprehension is more strongly associated with reading precursors than with task orientation.
- Preschool task orientation and oral language comprehension contributed to kindergarten task orientation.
- Oral language comprehension in Grade 3 was predicted by kindergarten oral language comprehension and task orientation, whereas Grade 3 reading fluency was determined solely by kindergarten reading precursors.
- Concurrent measures of oral language comprehension,

reading fluency, and task orientation each contributed unique variations to reading comprehension in Grade 3. Together, these accounted for 76% of the variance in Grade 3 reading comprehension.

- Preschool oral language comprehension had a significant and indirect effect on Grade 3 reading comprehension through kindergarten and Grade 3 oral language comprehension and kindergarten task orientation.
- Preschool reading precursors were associated with Grade 3 reading comprehension through kindergarten reading precursors and Grade 3 reading fluency.
- Preschool task orientation was indirectly related to Grade 3 reading comprehension through kindergarten task orientation and Grade 3 oral language comprehension.



Summary

- The findings suggest a reciprocal relationship between oral language comprehension and task orientation across time in the prediction of reading comprehension.
- The link between oral language comprehension and task orientation strengthened substantially from preschool to Grade 3.
- The modelling suggests that variations in reading comprehension is captured by the two components pertinent to the simple view of reading and task orientation.
- The results indicate that pathways to reading comprehension are propelled by behavioural factors relatively early—three years before the onset of formal

reading instruction.

- Individual differences were conspicuously stable in oral language comprehension from age 4 to 9 years and in reading precursors from age 4 to 6 years.
- Continuity was observed in task orientation from preschool to Grade 3.
- The modelling of the links between reading precursors and oral language comprehension supported their developmental independence from preschool to kindergarten.
- The final model included narrative listening comprehension and inference making over the age range of 4–9 years, text reading fluency, and task orientation. This accounted for 76% of the variance in Grade 3 reading comprehension.
- A reliable prediction of Grade 3 reading comprehension can be based on listening comprehension and inference-making skills measured as early as the age of 4 years.
- It is suggested that task motivation facilitates text comprehension in at least two ways. First, strong task orientation implies an attempt to approach and master the learning task, simultaneously focusing on the meaning of instruction. Second, task orientation implies intellectual responsibility and high coherence standards and higher aspiration levels, which in turn results in better reading comprehension.
- Comprehension can be supported by discussing the explicit and implicit information in stories and identifying narrative elements and protagonists' thoughts, feelings, and actions.

Language Outcomes of Contextualized and Decontextualized Language Intervention: Results of an Early Efficacy Study

eTale 2022

The present study examines whether a new contextualised language intervention (CLI) or an existing decontextualised language intervention (DLI) resulted in greater changes in children's language and narration than a no-treatment condition (CON). Both interventions were associated with statistically significant improvements on sentence- and discourse-level measures when compared to a no-treatment condition, with the CLI group performing the best.

Authors: Sandra Laing Gillam, Ronald B. Gillam, & Kellie Reece

Source: Gillam, S.L., Gillam, R.B., & Reece, K. (2012). Language outcomes of contextualized and decontextualized language intervention: Results of an Early Efficacy Study. *Language, Speech, and Hearing Services in Schools, 43*, 276-291, DOI: 10.1044/0161-1461(2011/11-0022)

The present study examines whether a new contextualised language intervention (CLI) or an existing decontextualised language intervention (DLI) resulted in greater changes in

children’s language and narration compared to a no-treatment condition (CON). In the study, 16 children aged 6-9 years were randomly assigned to the CLI and DLI groups, and 8 children were assigned to the CON group. Children in the CLI and DLI conditions received group intervention sessions of 50 min 3 times per week for 6 weeks. Both interventions were associated with statistically significant gains on sentence- and discourse-level measures when compared to a no-treatment condition, with the CLI group performing the best.

- School-age children with specific language impairments (SLI) often demonstrate difficulty in comprehending and producing narratives.
- Difficulties in one area (such as comprehension) often affect the performance in other areas (such as literate language use).
- Deficits negatively impact the ability of children with SLI to profit from instruction in the classroom without some form of intervention.

Contextualised language intervention (CLI)

- Contextualised language intervention is a treatment approach in which specific teaching steps are used to train multiple linguistic targets or curriculum-related skills within activities that involve rich, meaningful, and coherent references to people, objects, and actions.
- Topic continuity across activities is a key component of CLI.
- It is assumed that language is best learned when children engage in activities with more skilled participants who provide them with models and support within authentic communicative interactions.

Decontextualised language intervention (DLI)

- In a decontextualised language intervention, children

are taught language skills in discrete, teacher-directed activities with minimal topic continuity across the activities.
- In each activity, the topics and interactive contexts are different.

The study

The present study employed a nonrandomised, parallel group design to provide a low-cost test of our revised intervention to facilitate a larger, more costly, and more internally valid investigation.

Research question:

1. Will children who receive CLI or DLI present greater improvements on sentence-level or narrative-level language measures compared to children in a no-treatment control group (CON)?

Participants

The study included 24 children with learning impairments (LI). Of these, 8 received CLI, 8 received DLI, and 8 formed a CON group. Intervention was provided in a public school in three sessions of 50 min per week over 6 weeks in small groups of 3 or 4 students.

The CLI intervention procedure

- The CLI was structured around children’s literature and incorporated both oral and written language whenever

possible.

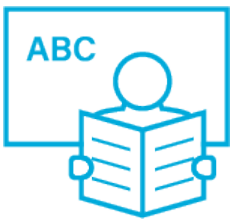
- Children were provided with multiple opportunities to talk about and share knowledge of the story content and use vocabulary and grammatical structures from the model stories.
- The clinician delivering the CLI encouraged the children to link relevant world knowledge and experiences to the vocabulary and sentence structures that were taught in each session.
- The specific intervention activities in the CLI included the following: listening to stories, answering comprehension questions, generating inferences, comparing/contrasting characters and actions across stories, discussing and defining the meanings of Tier 2 vocabulary, and brainstorming solutions to problems inherent in the stories.
- Tier 2 vocabulary includes words that are likely to be unfamiliar to children but represent ‘concepts’ with which children are familiar.

The DLI intervention

- Children in the DLI group answered questions and played games from the No-Glamour series published by LinguiSystems.
- The materials included a commercially packaged grammar game and situational drill cards designed to improve vocabulary, sentence complexity, and social language.
- Clinicians were instructed to engage the children in each game or card set for an average of 12.5 min.
- Clinicians were instructed to provide feedback in the form of focused stimulation, explanations, growth-relevant recasts, and vertical structures.
- Topic continuity or discontinuity was a critical difference between the DLI and CLI programs. Topics were discontinuous in the DLI program.

Findings

- The CLI group's post-test scores on the Recalling Sentences and Formulated Sentences subtests were significantly larger than the control group's post-test scores.
- The DLI group's post-test scores were significantly higher than the CON group's scores for Formulated Sentences but not for Recalling Sentences.
- The effect sizes for the CLI intervention were 81% larger (on average) than the effect sizes for the DLI intervention.
- There were significant differences between the CLI and CON groups for the TNL Narrative Language Index, the TNL Narrative Comprehension score, and the MISL microstructure score.
- The only significant difference between the narrative performance of the DLI and CON groups occurred for the MISL microstructure score.
- For the four narrative measures combined, the effect sizes for the CLI were nearly three times larger (on average) than the effect sizes for the DLI.



Summary

- The study assessed the language outcomes of children who

participated in a CLI and those who participated in a DLI.

- Both the CLI and DLI programs incorporated activities that involved listening to short stories, asking or answering questions, and brainstorming solutions to problems. In addition, children in both groups were asked to define words and to generate sentences containing vocabulary words.
- The primary difference between the interventions was that the CLI condition provided more topic continuity across activities that were presented in functional, narrative-based intervention contexts.
- Children in all three groups achieved similar scores on five of the six measures before intervention. The only exception was the Recalling Sentences subtest, in which the children in the CLI group had significantly higher scores than the children in the CON group.
- After intervention, children in the CLI group achieved significantly higher scores than children in the CON group on Recalling Sentences and Formulated Sentences.
- Children in the DLI group achieved higher scores than children in the CON group on Formulated Sentences but not on Recalling Sentences.
- Only the CLI group performed significantly differently from the CON group on the TNL Narrative Language Ability Index.
- The CLI group performed significantly better than the CON group on the comprehension measure and the microstructure measure, but not on the macrostructure measure.
- For the sentence-level measures, there were large or very large effect sizes for both the CLI and DLI groups over the CON group.
- It could be argued that both interventions were effective for improving children’s sentence-level language skills.
- There were important group differences in the size of

the effects. On average, the effect sizes for the CLI group were 81% larger than the effect sizes for the DLI group.

- The CLI approach yielded moderate effects (d = 0.43) on the general measure of narrative language ability and for the MISL macrostructure scale (d = 0.45), and large effects for the TNL Comprehension scale (d = 0.93) and MISL microstructure scale (d = 1.19).
- A finding of positive outcomes for children who received group therapy is promising news for clinicians whose caseload considerations prohibit or restrict the provision of individual treatment to children with LI.

Five Minutes a Day to Improve Comprehension Monitoring in Oral Language Contexts

eTale 2022

A systematic and explicit instructional routine for comprehension monitoring in oral language contexts was developed for children in pre-kindergarten. Results indicated that children who received the instruction improved at identifying inconsistencies in short stories compared to those

who received typical instruction, with a medium effect size (d = 0.57).

Authors: Young-Suk Grace Kim & Beth Phillips

Source: Kim, Y.-S. G. & Phillips, B. (2016). Five minutes a day to improve comprehension monitoring in oral language contexts. An exploratory intervention study with prekindergartners from low-income families. *Top Lang Disorders, 36*(4), 356-376, DOI: 10.1097/TLD.0000000000000103

Comprehension monitoring is not limited to the reading context, it also applies to the oral context for children's listening comprehension, which is a critical foundation for reading comprehension. A systematic and explicit instructional routine for comprehension monitoring in oral language contexts was developed for children at pre-kindergarten. Instruction was provided in small groups for approximately 5 min a day for 4 days a week over 8 weeks. Results indicated that children who received the instruction were better at identifying inconsistencies in short stories compared to those children who received typical instruction, with a medium effect size (d = 0.57).

- Oral language comprehension is an essential skill for daily interactions and for reading comprehension.
- Recent emerging evidence suggests that language comprehension at the discourse level (commonly referred to as listening comprehension) draws on a highly complex set of abilities and knowledge. These include working memory, attentional control, vocabulary, syntax, inference making, perspective taking, and comprehension monitoring.
- Successful comprehension of texts (oral or written) requires construction of a coherent mental model, which has been called the situation model.
- A proposition is the basic unit idea/thought.
- Initial and elementary propositions should be

interconnected to establish global coherence.

- The comprehender should evaluate and monitor their understanding of the text as the situation model is updated with incoming information.
- Comprehension monitoring is the ability to reflect on and evaluate one's comprehension of text (spoken or written).
- Comprehension is typically measured by assessing a child's ability to detect inconsistencies in stories.
- Good readers know when they fail to understand and are confused.
- Comprehension monitoring has been widely promoted as a strategy to help students resolve confusion or comprehension failure in the context of reading.

The study

The present study examines the potential effect of explicit instruction on comprehension monitoring in oral language contexts for children in pre-kindergarten from low socioeconomic family backgrounds. A brief instructional routine (lasting approximately 5 min a day) targeting inconsistency detection was developed. While Instruction was delivered in small groups (three to four children), the routine is flexible and appropriate for whole class or one-on-one instruction.

Participants

The study included 75 children at pre-kindergarten (mean age = 57 months), all of whom were recruited from high-poverty schools. Of the children, 41 were randomly assigned to the treatment condition and 34 were assigned to the comparison

(practice-as-usual) condition. Five children dropped-out, leaving 70 children in the post-test.

Comprehension monitoring assessment:

- Children heard stories consisting of two to three sentences and were asked to identify whether the stories were silly or made sense.

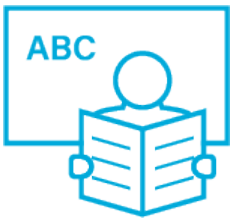
The intervention

- Intervention was conducted in small groups of four children, typically four times per week for 8 weeks.
- Each lesson had a scaffolded learning format of I-do, we-do, and you-do.
- Lessons were sequenced, starting from external inconsistencies and transitioning to internal inconsistencies, because internal inconsistencies were initially too challenging.
- The ratio of inconsistent versus consistent stories was approximately two to one.
- At the end of each lesson, the interventionist concluded by stating ‘when you listen to a story, you have to listen carefully so that you know if the story is silly or makes sense to you. If the story does not make sense to you, then you should stop, think about it, and ask questions.’

Findings

- Children had superior mean pre-test results on external inconsistency items compared to internal consistency items.

- The intervention’s effect size after adjusting for children’s pre-test was 0.57 (p = 0.008), which is considered medium.



Summary

- In this study, the effect of explicit instruction on children’s comprehension monitoring was examined.
- Explicit instruction on comprehension monitoring had a positive, medium sized effect after 8 weeks of small group instruction.
- The results indicate that children in pre-kindergarten can be taught to identify inconsistencies in short stories, regardless of whether they are external or internal.
- Children found comprehension monitoring instruction engaging and the silly and inconsistent stories amusing (when identified).
- One important aspect of the described instructional routine is its ease of use and flexibility.
- The lesson can be flexibly applied to varied group sizes such as individual children, small groups, or whole classes.
- During reading activities, the teacher may insert questions at appropriate moments about whether the focal part of the story makes sense to children and why.
- Teachers can employ a questioning strategy during conversations with individual children. For example, when things are not clear during a conversation, the teacher can explicitly request further information from

the child by stating ‘This part does not make sense to me. Would you tell me more about _?’

- The overall concept is to enhance children’s monitoring of their own understanding of stories or utterances in daily interactions and probe further when something does not make sense.

The Impact of Vocabulary Instruction on Passage-Level Comprehension of School-Age Children: A Meta-Analysis

eTale 2022

In this research, a meta-analysis of 37 studies on vocabulary interventions from pre-Kindergarten to Grade 12 was conducted to provide a fuller understanding of the impact of vocabulary on comprehension. Vocabulary instruction was found to be effective for increasing student abilities in comprehending text with custom measures less effective for standardised measures. Students with reading difficulties benefited more than three times as much as students without reading problems on comprehension measures.

Authors: Amy M. Elleman, Endia J. Lindo, Paul Morphy, & Donald L. Compton

Source: Elleman, A.M., Lindo, E.J., Morphy, P., & Compton, D.L. (2009). The impact of vocabulary instruction on passage-level comprehension of school-age children: A meta-analysis. *Journal of Research on Educational Effectiveness 2*(1), 1-44, DOI: 10.1080/19345740802539200

In this research, a meta-analysis of 37 studies on vocabulary interventions from pre-Kindergarten to Grade 12 was conducted to provide a fuller understanding of the impact of vocabulary on comprehension. Vocabulary instruction was found to be effective for increasing student abilities in comprehending text with custom measures less effective for standardised measures. Students with reading difficulties benefited more than three times as much as students without reading problems on comprehension measures.

- The ability to understand and gain knowledge from text is a fundamental skill required in every school subject and in everyday life.
- Large numbers of school-age children experience significant problems in learning to read.
- The knowledge hypothesis states that words are part of larger knowledge structures. Further, these knowledge structures (not the words per se) affect a person's comprehension.
- The aptitude hypothesis postulates there is no causal relationship between vocabulary and comprehension.
- According to the reciprocal hypothesis, most of children's growth in vocabulary occurs incidentally, not through instruction or conversation. This learning occurs incrementally over time through multiple exposure to words in varied contexts.
- While the two studied hypotheses provide a viable explanation for the relationship between vocabulary and comprehension, they are not mutually exclusive and each

probably provides a partial explanation.

Examples of different instructions used:

- Association: this instruction pairs association of the new word with its definition or synonym.
- Comprehension: this instruction requires that the student demonstrates comprehension of the meaning of the word by doing something with the definitional information.
- Generation: this instruction requires the students to generate a novel oral or written response using the word.

The study

The present meta-analysis asks the following questions concerning comprehension outcomes for students from pre-Kindergarten through to Grade 12:

1. Does vocabulary instruction affect passage-level comprehension?
2. What methodological characteristics are associated with effect size and need to be controlled to avoid confounding of the findings?
3. Do the same factors that affect comprehension influence vocabulary improvements in the same way?
4. Are the effects in vocabulary associated with the effects in comprehension?

Data

This meta-analysis included 37 articles that met the

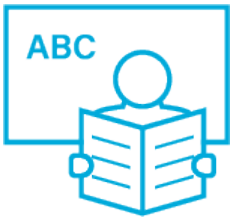
eligibility criteria. All eligible reports were coded for effect size and study characteristics. The d statistic was used as an effect size, which was calculated by taking the difference between the intervention group and the control group means and dividing by the pooled standard deviations of the means.

Findings

- The literature search yielded 37 eligible studies from which 44 effect sizes were derived for comprehension outcomes.
- A vocabulary measure was administered in 28 of the studies, from which 37 independent effect sizes were derived.
- Effects from standardised measures were minimal and effects associated with having reading difficulties were larger than those with not reading problems.
- The comprehension effect sizes for standardised measures ranged from −0.26 to 0.43 with an overall random weighted mean effect size of 0.1 (not significantly different from zero).
- The effect sizes for custom measures ranged from −0.06 to 1.46 with an overall random-weighted mean effect size of 0.50 (significantly different from zero). This means students who received vocabulary interventions outperformed students who did not receive such instruction on comprehension outcomes aligned to the treatment.
- The effect sizes for standardised vocabulary measures ranged from −0.24 to 0.46 with an overall random-

weighted mean effect size of 0.29 ($p < 0.01$). This indicates students who received vocabulary instruction increased their word knowledge on standardised tests.

- The mean effect sizes for custom measures of vocabulary ranged from −0.11 to 2.28 with an overall random-weighted effect size of 0.79 ($p < 0.01$). This demonstrates students who received vocabulary instruction had a wider vocabulary compared to students in control conditions.
- Students identified as having reading difficulties benefited more from vocabulary instruction on comprehension outcomes than students who had no indicated risk of a reading problem or disability.
- The results suggest the benefit of vocabulary instruction is more apparent on measures of vocabulary for younger students, whereas the benefit is more apparent on measures of comprehension for older students.
- If we assume the instrumentalist hypothesis is true, we would expect comprehension effects to be strongly and positively correlated with vocabulary effects. However, the results would indicate this is not true.



Summary

- Although a positive overall effect of vocabulary training on comprehension assessed with custom measures was found, the effect for standardised measures was minimal.
- The overall positive effects found for custom measures

suggest that vocabulary training increases comprehension for all students.

- Students identified as having reading problems benefitted more than students with no indicated reading problem by a factor of three.
- Students with reading difficulties made equivalent improvements in vocabulary knowledge as those students without reading difficulties.
- If students learn target words contained in the text, it can free up cognitive resources that can be allocated for the higher level processes of integrating text.
- Improvements in comprehension may be due to increased knowledge of the topics and the words learned.
- Regardless of the type of vocabulary instruction used, the same effects were produced on comprehension.
- Studies that utilised higher levels of discussion were associated with larger effects for vocabulary outcomes.
- Practitioners should use high levels of discussion to promote vocabulary development.

Playing Action Video Games Improves Visuomotor Control

eTale 2022

The present study found that action gamers have better lane-keeping and visuomotor-control skills compared to non-action gamers. Action gaming generally improves the responsiveness of the sensorimotor system to input error signals. The findings support a causal link between action gaming and enhancement of visuomotor control, with the suggestion that action video games can be beneficial training tools.

Authors: Li Li, Rongrong Chen, & Jing Chen

Source: Li, L., Chen, R., & Chen, J. (2016). Playing action video games improves visuomotor control. *Psychological Science, 27*(8) 1092–1108, DOI: 10.1177/0956797616650300

The present study found that action gamers have better lane-keeping and visuomotor-control skills than non-action gamers. For this study, non-action gamers were trained with both action and nonaction video games. After playing a driving or first-person-shooter video game for 5 to 10 hours, their visuomotor control improved significantly. Non-action gamers displayed no such improvement after playing a non-action game. Action gaming generally improves the responsiveness of the sensorimotor system to input error signals, and the findings support a causal link between action gaming and enhancement in visuomotor control. It is further suggested that action video games can be beneficial training tools.

- Playing action video games has been shown to result in a wide range of benefits for both basic and higher-level visual functions, such as contrast sensitivity, motion-direction discrimination, visuospatial resolution, visuospatial attention, and top-down guidance in visual searches.
- Gamers have enhanced eye-hand coordination and faster reaction times.

The study

The present study consists of four experiments:

1. How do people who do/do not frequently play action video games perform on a common driving task (lane keeping)?
2. Develop a visuomotor-control task for specifically examining visuomotor control underlying driving in action gamers
3. Non-action gamers played either a driving game or non-action game
4. Non-action gamers played either a first-person-shooter game or non-action game

Participants

Experiment 1 involved 12 action gamers and 12 non-action gamers. Action gamers reported playing ≥5 hours per week, while non-action gamers reported playing <1 hour per month.

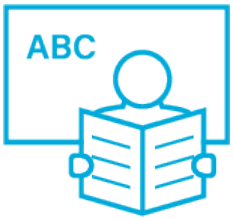
Experiment 2 involved 14 action gamers and 14 non-action gamers.

Experiment 3 involved 12 non-action gamers (who were randomly assigned to either action group and trained to play a driving game) and a control group (who were trained to play a non-action game). Training consisted of playing the video game for 10 sessions, each lasting 1 hour.

Experiment 4 involved 16 non-action gamers who were randomly assigned to action and control groups. The action group played a first-person-shooter game.

Findings

- Action gamers exhibited improved precision in lane keeping compared to non-action gamers (Exp. 1).
- Action gamers exhibited improved precision in visuomotor control (Exp. 2).
- The action group’s mean root-mean-square (RMS) target position error decreased after playing, while the control group’s mean RMS target position error remained constant (Exps. 3 and 4).
- The action group’s mean response gain increased after play, while control group’s mean response gain did not increase significantly (Exps. 3 and 4).
- The results of Exp. 3 indicate that playing a driving video game improves the responsiveness of the sensorimotor system to visual input errors. However, it does not have much effect on reaction time, the ability to anticipate input errors to generate lead control, or stability of the neuromuscular system.
- The results of Exp. 4 indicate that playing a first-person-shooting video game improves the responsiveness of the sensorimotor system and its ability to anticipate input error to generate lead control. This improvement in anticipation is accompanied by a decrease in stability of the neuromuscular system.



Summary

- With action gamers, their precision error was 57% smaller, their response amplitude was 24% larger, and their response delay was 29% shorter compared to non-action gamers.
- Action gamers had superior performance on the visuomotor-control task compared to non-action gamers.
- Different types of action video games have both common and different effects on the sensorimotor system.
- The findings of the current study support the claim that easily accessible action video games can be cost-effective training tools to help people improve the essential visuomotor-control skills used for driving.

Effect of Fine Motor Skills Training on Arithmetical Ability in Children

eTale 2022

The aim of the present study was to examine the effect of motor skills training on arithmetical abilities among 80 Grade 1 students. One result indicated that the intervention group (who received training in fine motor skills for 10 min) exhibited greater improvements in performance on an arithmetic task and a pegboard compared to the active control group (who read their favourite book for 10 min).

Authors: Atsushi Asakawa, Taro Murakami, & Shinichiro Sugimura

Source: Asakawa, A.; Murakami, T.; Sugimura, S. (2019). Effect of fine motor skills training on arithmetical ability in children. *European Journal of Developmental Psychology, 16*(3), 290-301, DOI: 10.1080/17405629.2017.1385454

The aim of the present study was to examine the effect of motor skills training on arithmetical abilities among 80 Grade 1 students. One result demonstrated that the intervention group (who received training in fine motor skills for 10 min) achieved improved performance on an arithmetic task and a pegboard compared to the active control group (who read their favourite book for 10 min). These findings suggest that the training presented in this study is an appropriate programme for improving fine motor skills and that fine motor skills have a significant influence on arithmetical abilities in children (with a medium effect size).

- When learning arithmetic at an early stage, children tend to use their fingers to represent and count numbers.
- Based on the embodiment theory, claims have been made that finger movements are related to arithmetic

development.

Possible explanations for the link between arithmetical abilities and fine motor skills:

- Brain areas governing these two abilities are close to each other; hence, they might exhibit similar developmental patterns.
- The executive function might mediate the relationships.
- Numerical operation is not merely abstract thinking—it is also based on physical, embodied experiences.

What is finger gnosis?

- Finger gnosis is the ability to identify the form of the hand and position of fingers without visual feedback.
- Finger gnosis is a different aspect of finger processing from fine motor skills.

The study

The purpose of this study was to clarify the effect of fine motor skills training on arithmetical ability in children in the first grade of primary school.

Hypothesis:

- The training programme in this study is only expected to influence fine motor skills and arithmetical abilities, not finger gnosis.

Participants

The study involved 80 Grade 1 students, who were randomly

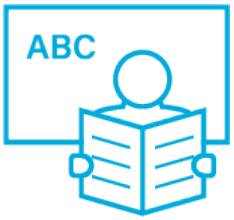
assigned to either a fine motor training group or a control group. In the intervention group, fine motor skills training was conducted instead of a reading activity (which was continued in the control group) for 3 weeks after pre-test.

Fine motor skills training

- Bead stringing: children were required to string as many beads as possible with one hand at a time for one minute.
- Finger opposition: children performed finger opposition movements (thumb to index, medium, ring, and little fingers) with each hand five times.
- Pulling each finger: children placed their hands in front of their chest with the right palm facing them and left palm facing away. They clasped the fingers of both hands together and pulled their left hand towards their right side while pulling their right hand to the left.

Findings

- The training was effective in improving fine motor skills.
- The fine motor skills training was effective in improving children’s arithmetical abilities.
- The fine motor skills training in this study was not effective in improving finger gnosis.



Summary

- The arithmetic scores of the fine motor training group showed improvement after the 3 week intervention period, whereas those in the reading group showed no improvement.
- It appears that fine motor skills have a significant influence on arithmetical abilities (given the medium effect size).
- For the first time, the present study has provided evidence suggesting there may be a causal relationship between fine motor skills and arithmetical abilities.
- Fine motor skills training does not improve finger gnosis.
- According to the ‘brain’ view, the brain areas underlying both finger movement and arithmetical ability are close to each other.
- According to the ‘mediation’ view (which proposes that executive function mediates the relationship between fine motor skills and arithmetical ability), it is possible that arithmetic abilities develop because of improvements in executive function through fine motor skills training.
- According to the ‘embodiment’ view, numerical operations are not merely abstract thinking—they are also based on physical, embodied experiences.
- The results cannot confirm whether the mediation or embodiment view best fits the results.

Learning Letters with the Whole Body: Visuomotor Versus Visual Teaching in Kindergarten

eTale 2022

The present study assessed the impact of a teacher-implemented visuomotor intervention programme of teaching cursive letter knowledge to children aged 5 years. While there was greater improvement in letter recognition following the visuomotor intervention, results were mixed for letter handwriting.

Authors: Florence Bara & Nathalie Bonneton-Botté

Source: Bara, F. & Bonneton-Botté, N. (2018). Learning letters with the whole body: Visuomotor versus visual teaching in kindergarten. *Perceptual and Motor Skills, 125*(1), 190-207. Doi: 10.1177/0031512517742284

The present study assessed the impact of a teacher-implemented visuomotor intervention programme for teaching cursive letter knowledge to children aged 5 years. A programme in which letters were explored with the arm and whole body was compared with a typical visual training programme. There was greater improvement in letter recognition following the visuomotor

intervention although results were mixed for letter handwriting. This indicates a combination of both visuomotor and visual training might be the most efficient method.

- Letter knowledge acquisition is an important component of a child's literacy development and is one of the strongest predictors of subsequent reading and spelling abilities.
- When learning involves both perceptual and motor systems, there is an interaction between perception and action.
- Visual representations of letters are linked to motor representations through handwriting.
- Related to perception and the motor interaction process, some studies with young children have shown that overt (rather than just passive) motor action further enhances letter perception.
- Formal pencil-and-paper writing depends upon an accurate visual representation of the letters, a degree of coordination between visual perception and finger movements, and sufficiently developed fine motor skills.
- Impaired handwriting is frequently associated with developmental coordination disorder. In particular, it has been closely linked to fine motor manipulative disability and to coordination problems.
- An efficient letter knowledge intervention must include both handwriting practice and direct instruction in letter knowledge.

What are the subskills of letter knowledge?

- Letter recognition: the ability to recognise the shape of the letter
- Letter naming: associating the shape of the letter to its name
- Letter sound knowledge: finding the sound corresponding to the shape or name of the letter
- Letter writing: the ability to trace the letter with a

pen in accordance with its shape and direction

The study

This study investigated a novel kindergarten-level multisensory teaching intervention for letter knowledge, whereby alphabet letters are taught through gross motor movements—pupils are asked to produce letters with their arms or whole body and without using a pencil. As gross motor development occurs earlier than fine motor development, gross motor movements should be particularly helpful for young children or those with disabilities.

Hypotheses:

- A whole-body visuomotor training programme would be more efficient than a visual letter exploration programme.
- An improvement in hand-writing quality and fluency can be expected.

Participants

The study involved 72 normally-developing kindergarten pupils (aged 5 years) living in France, who were assigned to either the whole-body visuomotor or visual exploration training programme.

Interventions

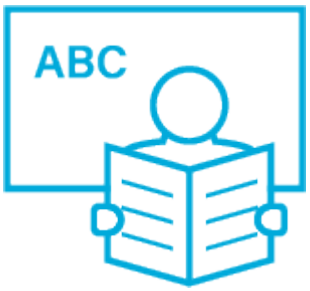
- The pupils were divided into groups of 6–10 and underwent a 45 min session in which two letters were successively learned.
- All children completed six sessions over six weeks.

- The 12 letters used for training sessions and their order of presentation were chosen according to their frequency in the French language and because they represented different types of letters.
- Each visuomotor and visual training session started by giving the name and the sound of the letter and ended with letter-recognition and letter-handwriting tasks.
- **The visual training sessions** included visual exploration, where a letter was displayed on the board and pupils were asked to draw the letter with their eyes.
- **Whole body visuomotor training sessions** included exploration with the arm (where the teacher drew the letter in the air with their arm and pupils were required to repeat this action) and exploration with the body (where the letter was drawn on the ground and each pupil walked round the outline). These exercises initially conducted with eyes open, then with eyes shut.

Findings

- The students improved their letter recognition score more with the whole body visuomotor training programme than with the visual programme.
- The training groups did not differ in their progress in letter-name knowledge or letter writing under dictation (both improved between the pre- and post-tests in both training programs).
- Mean quality scores and stroke direction (handwriting direction) in letter copying improved more after the visuomotor training programme.
- Mean number of pauses and mean duration of pauses

decreased and mean velocity increased between the pre- and post-tests in both training programs; thus, there were no group differences.
- Pupil handwriting fluency improved more in the visual training programme than in the visuomotor training programme.



Summary

- The main finding was that letter recognition improved more following the visuomotor training programme than with the visual training programme. This implies a strong relationship between the visual and the motor systems in reading and writing processes.
- Regarding the kinematic measures, the visuomotor training programme only had a positive effect on stroke direction. It is interesting to note that a gross motor movement can transfer to a fine motor movement with the hand.
- An unexpected result was that handwriting fluency improved more following the visual training programme than with the visuomotor training programme.
- The present study provides support for a gross-motor visuomotor intervention to promote such specific components of letter learning as improving letter recognition and improving two aspects of letter writing (stroke direction and overall quality). It should be noted that handwriting speed and fluency improved more with a visual instructional method.

- A question emerges as to whether the combined use of visuomotor training and visual letter exploration might prove to be a more effective teaching method than either technique used alone.

Training Working Memory of Children with and without Dyslexia

eTale 2022

In this study, a software application for elementary school-age children was specifically developed with the aim of improving the operational efficiency of working memory. Short-term effects of the programme could not be proven and only the visuo-spatial Corsi block span exhibited a training effect over a period of three months.

Authors: Claudia Maehler, Christina Joerns, & Kirsten Schuchardt

Source: Maehler, C.; Joerns, C.; Schuchardt, K. (2019). Training working memory of children with and without dyslexia. *Children, 6*(47), doi: 10.3390/children6030047

A software application for elementary school-age children was specifically developed for this study, with the aim of improving the operational efficiency of working memory. The phonological loop, the visuo-spatial sketchpad, and the central executive were trained in 18 sessions over a period of 6 weeks. The trained test group was composed of Grade 3 students, of which 43 were and 27 were not affected by dyslexia. The untrained control group comprised 41 Grade 6 students with dyslexia and 28 without dyslexia. Short-term effects of the programme could not be proven and only the visuo-spatial Corsi block span exhibited a training effect over a period of three months.

- Reading problems become evident from the start of a child's school career, manifesting as difficulties in reciting the alphabet or through delayed (or incorrect) character recognition.
- While affected children improve overall in their literary language performances, they continually lag behind compared to unimpaired fellow students.
- It is no longer controversial that dyslexia constitutes a phonological information processing disorder.
- Dyslexia is accompanied by working memory deficits, particularly in the phonological loop.

Three subsystems of working memory and tasks with which they can be measured

- **A central executive** is often measured by complex span tasks, such as remembering information and recalling it backwards.
- **A phonological loop** is usually measured via a serial reproduction of verbal information (such as word span)
- **A visuo-spatial sketchpad** is typically measured by recalling pictures devoid of content or spatial positions.

The study

The present study evaluates the long-term effects of a training programme. The short-term effects immediately following training sessions have already been reported. The findings substantiate performance improvements in the visuo-spatial sketchpad and central executive subsystems for the group of typically-developing third-grade students, and only in the central executive for the children with dyslexia.

Research questions:

- Can training effects be maintained over a longer period or could they occur after a certain period of time?
- Can dyslexic children with notably poor working memory performance benefit from the training (show a long-term effect) with regard to their working memory performance?

Participants

Participants in the study were 139 Grade 3 students from both rural and urban areas. They were assigned to four groups according to whether they had dyslexia and whether they participated in training. The groups were dyslexia trained (n = 43), dyslexia untrained (n = 41), control group trained (n = 27), and control group untrained (n = 28). All children were examined within a pre-test, post-test, and follow-up design, while school performance, intelligence, and working memory capacity were assessed at pre-test and working memory performance was tested at follow-up.

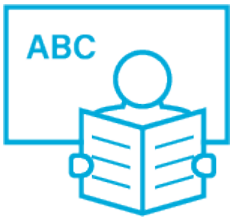
Training

A computer game training-method named AGENT 8-1-0 comprised of 18 training sessions. Five working memory tasks were assigned

in each session: two games for improving the phonological loop’s capacity, one game for the visuo-spatial sketchpad, and two games for stimulation of the central executive.

Findings

- Significant differences between dyslexic and non-dyslexic children appeared in all tasks of the phonological loop and the central executive (except for object span and Corsi block backwards). In contrast, no differences were identified in the visuo-spatial working memory tasks.
- Substantial training effects could not be detected in either the phonological loop or central executive tasks.
- Significant improvements in all groups were only found in the Corsi block task (except for the untrained group with dyslexia).
- Improvements cannot be attributed to the training only, since the untrained control group also made progress.
- No significant triple interaction between initial working memory performance, training, and time of measurement could be detected for the tasks performed.
- No significant training effects could be identified, meaning that children with dyslexia (and especially poor working memory performance) do not benefit more from training compared to children with dyslexia who have an initially higher performance.



Summary

- Neither dyslexia-unaffected nor affected children experienced long-term improvement in working memory performance—only the visuo-spatial Corsi block yielded substantial training results.
- For children with dyslexia, and especially disadvantageous initial working memory performance regarding the three subsystems of working memory, no performance increase through training could be determined.
- Very intensive practice (tri-weekly sessions of 45 minutes over a course of 6 weeks) does not enable the children to process and memorise greater quantities of information over a longer period.
- Within the present controversy over the trainability of working memory, the results seem to support the sceptics regarding the efficacy of such endeavors.
- If increases in capacity through memory expansion or improved automatic processing appear to be impossible, an intervention must focus on the remaining determinants of memory capacity (especially on memory strategies and meta-memory).
- For children with dyslexia, the recommendation of a functional exercise treatment for reading and writing remains valid. Specifically, this should include applied strategies and self-monitoring of the individual reading and writing processes.

Interventions Targeting Working Memory in 4-11 Year Olds within Their Everyday Contexts: A Systematic Review

eTale 2022

Direct training on working memory (WM) tasks and practicing certain skills that can impact indirectly on WM (such as physical activity, fantastic play, and inhibition) both produced improvement on WM tasks, with some benefits for near-transfer activities. The common ingredient across effective interventions was the executive-loaded nature of the trained task.

Authors: Anita Rowe, Jill Titterington, Joni Holmes, Lucy Henry, & Laurence Taggart

Source: Rowe, A., Titterington, J., Holmes, J., Henry, L., & Taggart, L. (2019). Interventions targeting working memory in 4-11 year olds within their everyday contexts: A systematic review. *Developmental Review, 52*, 1-23, https://doi.org/10.1016/j.dr.2019.02.001

The aim of this review is to conduct a systematic examination of the effectiveness of non-computerised interventions with

4–11 year olds to identify the following: their effects on working memory (WM); whether benefits extend to near- and far-transfer measures; if improvements are sustained over time; the active ingredients; and the optimum dosage. Both direct training on WM tasks and practicing certain skills that may impact indirectly on WM (such as physical activity, fantastic play, and inhibition) produced improvement on WM tasks, with some benefits for near-transfer activities. The common ingredient across effective interventions was the executive-loaded nature of the trained task.

- Working memory is the ability to hold in mind and mentally manipulate information over short periods in the face of distraction.
- The capacity of WM is limited, it develops more in the first 10 years of life than at any other time, and it reaches adult capacity levels around the age of 14 years.
- Children with poor WM struggle to cope with the heavy WM loads of the classroom, which can result in them failing to complete individual learning activities. Moreover, as problems accumulate, this leads to poor academic achievement.

Working memory models:

- Working memory models involve two key features: high-level attentional control plus temporary storage
- Memory tasks can be differentiated into simple span tasks (involving temporary, passive storage of material) and complex span tasks (requiring the concurrent storage and processing of information while relying on attentional resources under executive control).

Effectiveness research of WM training:

- Theoretical perspective: the goal has been to understand the underlying cognitive processes by exploring the

extent to which training can improve WM and by identifying variables that moderate or mediate the effects of training and transfer to other cognitive functions.

- Applied perspective: the focus has been on investigating the impact of WM training on outcomes relating to real-world skills (such as attention, language, and academic achievement).

The study

The current review is the first to focus specifically on the effectiveness of non-computerised WM interventions applied within children's everyday contexts. The aims of the review are to map the types of interventions that have been implemented with young children in everyday contexts and examine the theoretical framework/s used to underpin them.

Research questions:

1. What types of WM interventions are implemented and what is their theoretical underpinning?
2. What are the effects of the interventions on WM and what aspects of WM (if any) are impacted?
3. Do WM improvements (if any) extend to similar untrained WM tasks (near-transfer effects) or dissimilar abilities linked with WM (far-transfer effects)?
4. Are WM improvements durable over time?
5. What are the active ingredients and the optimum dosage of effective interventions?

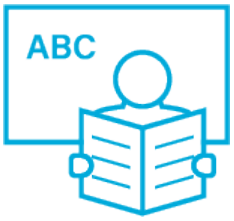
Eligibility criteria of the studies:

- conducted with children aged 4–11 years
- implemented any intervention that targets WM and is applied within children's everyday contexts
- employed a randomised controlled, quasi-experimental, or single case experimental design
- included at least one pre- and post-intervention measure of WM

Findings

- The included studies were classified into four intervention types: adapting the classroom environment; direct WM training without strategy instruction; direct WM training with strategy instruction; training skills that indirectly affect WM.
- In one paper, the effects of adapting the classroom environment on children's WM skills were investigated. While a positive association between teacher's use of strategies and children's post-intervention reading and spelling scores was identified, this association was also observed on pre-intervention measures of reading comprehension. This means the most effective teachers were already using appropriate strategies prior to the intervention.
- All three studies that implemented a direct WM training approach without strategy instruction reported improvements on trained WM measures.
- Five studies implemented direct WM training with strategy instruction, of which two trained short-term memory (STM) and three targeted executive-loaded WM (ELWM). Overall, the results suggest that effects on trained WM were observed when ELWM tasks were trained.

- Of the nine studies in which skills that may indirectly impact WM were trained, five studies implemented a physical activity intervention in which four found significant improvements in ELWM skills.
- Two studies investigated the effects of training phonological awareness on WM. It was suggested that rhyme and vocabulary training do not improve VSTM skills while phoneme awareness training produce positive effects.
- One study suggested that children's fantastical play skills can be improved through intervention, which can strengthen VSTM skills. In another study, inhibitory control was improved by training and produced effects on WM, attention, and behaviour.



Summary

- The first research objective was to identify both the types of WM interventions implemented and their theoretical underpinnings. The range of intervention approaches included the following: adapting the environment to reduce WM loads; direct WM training without strategy instruction; direct WM training with strategy instruction; and training skills that may indirectly impact on WM. Many of the studies lacked a clear theoretical account of why the intervention should impact WM.
- The second research question was to identify the effects of interventions. A significant outcome of this review is that WM skills can be altered through diverse

interventions, particularly in relation to verbal WM skills (which were more frequently measured than the visuospatial domain). Further, it would appear that ELWM skills are more amenable to change compared to STM skills.

- For the third and fourth research questions (identify any near- and far-transfer effects and the durability of WM improvements over time), the evidence was limited because few studies measured these outcomes. Preliminary evidence suggests that certain direct and indirect WM tasks have the potential to produce near-transfer effects on similar WM tasks and far-transfer effects on areas such as reading comprehension, numeracy skills, attention and behaviour.
- The final research question concerned the active ingredients and optimum dosage requirements for WM interventions. The most effective tasks were executive-loaded, meaning they tap into attentional resources under executive control (such as listening recall, odd one out, backward digit recall, verbal and visuospatial dual tasks, and word list updating). Of the indirect WM tasks, cognitively-demanding physical activity, fantastical play, and inhibition training are suggested as being beneficial to ELWM. The optimum dosage required to produce training effects remains uncertain because dosage variables were often unreported or varied significantly across studies. However, relatively short interventions of 5–6 weeks total duration were shown to be effective.

Multicomponent Reading Interventions for Students with Intellectual Disability

eTale 2022

The purpose of this literature review was to examine the characteristics, outcomes, and quality of multicomponent reading interventions for students with intellectual disability (ID). Findings indicate that students with ID who were exposed to multicomponent reading programmes significantly improved their reading skills compared to their peers with ID who received traditional sight word instruction and their previous reading performance.

Authors: Kemal Afacan, Kimber L. Wilkerson, & Andrea L. Ruppar

Source: Afacan, K., Wilkerson, K.L., & Ruppar, A.L. (2018). Multicomponent reading interventions for students with intellectual disability. *Remedial and Special Education, 39*(4), 229-242. Doi: 10.1177/0741932517702444

Reading instruction for students with ID has traditionally focused on single skill instruction such as sight word reading. The purpose of this literature review was to examine the characteristics, outcomes, and quality of multicomponent reading interventions for students with ID. Findings indicate that students with ID who were exposed to multicomponent reading programmes significantly improved their reading skills compared to their peers with ID who received traditional sight

word instruction and their previous reading performance. This literature review highlights effective strategies used to provide multicomponent reading instruction to students with ID.

- Compared to students receiving services in other disability categories and to their peers without disabilities, students with ID usually have less well-developed reading skills.
- Four out of five students with ID do not even achieve minimum levels of proficiency in reading, particularly in the areas of contextualised word recognition, narrative reading comprehension, phonemic awareness, and writing vocabulary.
- Only 9% of students with disabilities and 40% of students without disabilities perform at proficient (or above) levels in Grade 8 reading.
- Results from a meta-analysis (Edmonds et al. 2009) of 13 studies suggested that student comprehension skills significantly improved if they received the following: a) targeted reading instruction in comprehension, b) instruction in word reading strategies, or c) multicomponent reading instruction.
- The term multicomponent refers to a type of instruction that includes at least two of the five components of reading: phonemic awareness, phonics, fluency, vocabulary, and comprehension.
- Students with ID educated in general education settings outperform students placed in self-contained classrooms in their use of literacy skills, independent living, and social and emotional skills.

The study

The purpose of this review was to examine the characteristics, outcomes, and quality of multicomponent reading interventions for students with ID.

Research questions:

1. What are the characteristics of multicomponent reading interventions for student with ID, and what are the characteristics of the students who have participated in these studies?
2. What teaching strategies have been effective when implementing multicomponent reading interventions for students with ID?
3. What is the overall quality of multicomponent reading intervention studies?

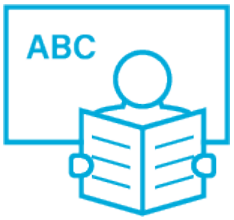
Seven articles met the inclusion criteria, which were then reviewed and coded according to their descriptive characteristics and methodological soundness.

Findings

- A total 375 students with ID (mean age range 7.5–9.4 years) participated in multicomponent reading interventions across the 7 studies.
- In all studies, teachers were the interventionists and the sessions lasted an average of 50.3 min within the range 30–90 min.
- Interventions took place in self-contained special education classrooms.
- The duration of interventions ranged from 12 weeks to 4

years.

- Even though each programme employed a somewhat different approach to reading instruction, there were some similarities among interventions across the studies.
- Researchers used a read-aloud strategy in all interventions.
- Five studies used repeated trials, five studies used prompting procedures, and five studies used time delay procedures.
- Although all studies demonstrated a multicomponent aspect, they utilised unique approaches to teach concepts of print, phonemic awareness, phonics, vocabulary, fluency, and comprehension skills to students with ID.
- The most common skills measured for concepts of print were pointing to the title, pointing to the author of the book, teaching students to track from left to right, and pointing to individual words.
- The most common skills measured for phonemic awareness were phoneme blending, phoneme segmenting, initial sound identification, and rhyme recognition.
- The most common skills measured for phonics were matching letter names and individual sounds, sight word recognition, and letter naming skills.
- For vocabulary, all studies measured the meaning of individual words while two studies measured picture-word matching skills.
- In three studies, fluency was measured when students were reading a passage they had not previously read.
- To measure comprehension, all studies used read aloud, three studies used prompting (such as asking questions while reading), and three studies used approaches that relied on pictures to predict.



Implications

- Six of the seven studies demonstrated that multicomponent reading interventions were associated with improved reading skills for students with ID.
- Both the duration of interventions and student IQs affected literacy acquisition. If students had a lower IQ level, the multicomponent intervention needed to be delivered over a more extended period of time and with greater intensity.
- Different students may need different amounts of time to respond to multicomponent interventions.
- It is possible to integrate several evidence-based strategies such as direct instruction, time delay, repeated trials, and read aloud into a multicomponent programme.
- Providing phonemic awareness instruction in early grades is vital for the reading development of students with ID because they do not easily develop phonemic awareness skills.
- Research on multicomponent reading instruction should be extended to general education (inclusive) classrooms in which students with ID are taught alongside students without disabilities.