Abstract

Introduction: The objective of this systematic review was to synthesise the evidence for cognitive strategy training to determine its effectiveness to improve performance of activities of daily living in an adult neurological population.

Method: Medline, CINAHL, EMBASE, PSYCInfo, PsycBITE, and Cochrane Central Register of Controlled Trials and Cochrane Database of Systematic Reviews were searched until August 2019. Studies examining the effect of cognitive strategy training on functional performance were included. Population criteria included adults (>18 years) with non-progressive neurological conditions. External and internal validity of included studies was systematically evaluated using a methodological quality assessment appropriate for each study design. A content analysis was conducted of methodologies used.

Findings: Fourty-one studies met the inclusion criteria and were appraised for content, sixteen randomised or quasi-randomised trials were meta-analysed. Trial quality was generally 'good', PEDro scale scores ranged from 3 to 8 (out of 10). For activity performance outcomes post-intervention, there was a significant benefit of cognitive strategy training over usual care, SMD = 0.79, 95% CI 0.49, 1.09 ($p < 0.00001$).

Conclusion: More high-quality research is needed to strengthen the evidence base for cognitive strategy interventions to improve activity performance outcomes for adults with non- progressive neurological conditions.
Systematic review registration: PROSPERO CRD#

Keywords: rehabilitation, occupational therapy, activities of daily living, cognitive neurosciences

Introduction

Cognitive strategies are mental plans of action that assist the person to approach task performance systematically, thus allowing people to learn new skills and perform tasks with improved accuracy and efficiency (Toglia et al., 2012). Cognitive strategy use is common in task performance when people without a neurological condition are faced by novel or challenging tasks (Bottari et al., 2014; Toglia et al., 2012). After neurological impairment, however, people frequently experience persisting physical, sensory and cognitive impairments that impact on their ability to perform everyday tasks. Activities that were previously familiar present the individual with novel challenges as they attempt to perform with altered capacity. As a result, there is an increased need to use cognitive strategies to support and improve the performance of everyday tasks. The ability to select and efficiently use cognitive strategies is commonly impaired (Kennedy et al., 2008; Krasny-Pacini et al., 2014). For example, individuals may not anticipate difficulties that will arise during task performance and consequently fail to initiate strategy use as the need arises or they may not spontaneously generate a range of strategies and as a result persist in using inefficient strategies (Bottari et al., 2014; Kennedy and Coelho, 2005).

Cognitive strategy-based interventions aim to promote functional recovery by restoring the individual’s ability to use cognitive strategies to compensate for impairments resulting from their neurological condition (Chung et al., 2013; Geusgens et al., 2007b).It has been suggested that cognitive strategy interventions have potential to promote additional functional recovery beyond intervention because an important emphasis is teaching the individual to generalise skills learned to solve performance challenges not directly addressed in intervention. Cognitive strategy interventions are of particular relevance to occupational therapists as a means to facilitate client goal attainment and improve the client’s ability to participate in meaningful activities of daily living in a variety of environments. As a result, there is growing interest in cognitive strategy training and several different interventions or approaches have been described.

Previous systematic reviews have examined the efficacy of cognitive rehabilitation interventions, including cognitive strategy training, for individuals with executive impairments following traumatic brain injury (Cicerone et al., 2011; Kennedy et al., 2008; Cicerone et al., 2005; Cicerone et al., 2019; Kumar et al., 2017) and stroke (Chung et al., 2013; Poulin et al., 2012). Findings suggest that cognitive strategy training may improve performance on measures of executive functioning (Chung et al., 2013; Poulin et al., 2012; Cicerone et al., 2011; Cicerone et al., 2019). However, the effect of cognitive strategy training on performance of everyday tasks is largely inconclusive in these previous systematic reviews. In addition, new studies investigating the efficacy of cognitive strategy training have been published since these earlier reviews. Therefore, the purpose of this review was to determine whether cognitive strategy training improves performance of everyday tasks for adults with neurological conditions, including traumatic brain injury and stroke. The review was guided by the research question: "Is cognitive strategy training effective at improving activities of daily living in adults with neurological conditions?"

Method

Design and search strategy

A systematic review was conducted. The PRISMA guidelines were followed in the conduct and reporting of this systematic review (Moher et al., 2009). Prior to data collection, the review was registered with the PROSPERO registry for systematic reviews (CRD#). Electronic searches were conducted of Medline, CINAHL, EMBASE, PsycINFO, PsycBITE and the Cochrane Central Register of Controlled Trials databases from inception until August 2019 for relevant peer-reviewed studies published in English. A health sciences librarian was consulted in the selection and development of the search strategy using the PICOS framework (population, intervention, comparison, outcome, study design) including identifying keywords and medical subject headings (MeSH). Search terms relating to stroke or traumatic brain injury, cognitive strategies and activities of daily living were combined to identify relevant articles. Reference lists of selected studies and relevant systematic reviews were reviewed to identify any additional eligible studies. Database searches were uploaded to EndNote software and duplicates were removed. Search results were then uploaded to Covidence (www.covidence.org) and titles and abstracts of studies were screened for eligibility by one reviewer (author 1). Two reviewers (authors 1 & 4) then independently screened the full text of potentially eligible studies for inclusion using predetermined criteria (Table 1). Disagreements were resolved through discussion, with adjudication by a third reviewer (authors 2, 3 or 7) when required.

Selection criteria

Participants. Studies were included if they involved adult participants with non-progressive, neurological conditions (non-traumatic or traumatic causes). The number of participants, their mean age and time since onset of acquired brain injury and type of rehabilitation setting were recorded to examine the similarity of the studies.

Intervention. Studies were included if they examined the effect of cognitive strategy interventions. Cognitive strategies were defined as 'goal-directed and consciously controllable processes that facilitate or support performance as learners develop internal procedures that enable them to perform the desired skill' (McEwen et al., 2009a: 263). Comparative interventions included usual care (also known as standard therapy or conventional therapy), any other cognitive rehabilitation approach, or no-intervention controls.

Outcome. Studies were considered if they included at least one outcome measure of performance of everyday activities (such as self-care, productivity or leisure), which could be either a standardised measure or observational assessment. In studies where several activity performance measures were available, reviewers chose the outcome measure that most closely reflected performance of meaningful activities of daily living. Activity performance outcome measures used and timing of measurement was recorded to assess similarity of studies.

Study design. Intervention studies of any design were included, given the recency of the intervention approach.

Data extraction

One reviewer (author 1) extacted data on study design, participant characteristics (including age, diagnosis and time since injury), a description of the experimental and comparator intervention (including content of intervention, rehabilitation setting, timing of intervention post-injury, duration and dosage) and outcome measures assessed. Two reviewers (authors 1 and 7) extracted outcome data. Outcome data extracted included sample size, and results for activity performance measures. Where available, we extracted pre/post mean change scores and their standard deviations (SD), confidence intervals and p-values, and if not available we extracted post-intervention scores (e.g. mean (SD) or median (interquartile range) scores). All calculations were based on the data in the published manuscript, except in one case where additional data was requested and provided by the study authors (Kessler et al., 2017). Where included studies reported insufficient information (e.g. missing SD), data were converted to enter an estimated value using methods described in the Cochrane Handbook of Systematic Reviews (Higgins and Green, 2011). All outcome data and calculations were independently crosschecked by a third reviewer (author 6).

Risk of bias and methodological quality assessment

Two researchers (authors 1, 4 and 5) independently rated the methodological quality of included studies using an appropriate methodological quality assessment tool for each study design. Consensus was reached through discussion where there were differences in ratings. A third author (authors 5 and 7) was consulted to resolve differences in ratings where consensus could not be reached. Only the ratings of randomised and quasi-randomised controlled trials are reported; all other ratings were used to determine the internal / external validity of the overall body of literature.

The methodological quality of randomised controlled trials and quasi-randomised controlled trials was assessed using the Physiotherapy Evidence Database Scale (PEDro scale). The PEDro scale is a reliable (Maher et al., 2003) and valid (de Morton, 2009) criterion-based measure of trial quality. It examines 11 criteria to determine the selection, performance, detection, and attrition biases present within a study. Scores range from 0-10. Studies that score 9-10 on the PEDro scale are considered to represent ‘excellent’ methodologically quality, 6-8 ‘good’ quality, 4-5 of ‘fair’ quality, and 3 and below of ‘poor’ methodological quality. Where available, scores were extracted from the Physiotherapy Evidence Database (www.pedro.org.au). Where a study was not included on the PEDro database, two researchers (authors 1 and 4) independently rated the study.

Non-randomised comparative study designs were rated using the Downs and Black Checklist (Downs and Black, 1998). This checklist provides a profile of methodological quality across 4 areas including; study reporting, external validity, internal validity (bias and confounding) and statistical power. We used a modified version of scoring for the statistical power criterion previously employed in other studies (Silverman et al., 2012), thus producing a total score of 28 with higher scores indicating stronger methodological quality.

Single participant designs were rated using the Risk of Bias in N-of-1 Trials (RoBiNT) Scale (Tate et al., 2015). The RoBiNT rates across 2 subscales: the internal validity scale which examines design, randomisation, behaviour sampling, participant, practitioner and assessor blinding and treatment adherence; and the external validity and interpretation scale which assesses reporting of baseline characteristics, setting, dependent variable, independent variable, raw data record, data analysis, replication and generalisation. The RoBiNT is scored out of a total of 30, with higher scores indicating stronger methodological quality.

Data synthesis

A content analysis was conducted of all included studies based on the steps described by Cavanagh (1997) to describe the aim, contents and format of cognitive strategy interventions. Extracted data was coded using predetermined categories developed by author 1. The categories were reviewed and discussed by authors 2,3 and 4 to ensure they were adaquate and comprehensive.The level of evidence of included studies was appraised using the National Health and Research Council Hierarchy of Levels of Evidence Framework (National Health and Medical Research Council, 2009), Table 2. Using the quality assessment scores, each study was evaluated for its internal and external validity and rated as demonstrating high' (no threats present), 'moderate' (one or two threats exist), or 'low' (more than two threats to validity exist). To determine the efficacy of cognitive strategy training and make recommendations based on the highest level of evidence, only randomised or quasi-randomised trials were included in the meta-analysis. Although trials used different outcome measures, the outcomes of interest were similar (improvement in activity performance) and the interventions were evaluated to be sufficiently homogenous to justify meta-analysis. Post-intervention and follow-up scores were used to obtain the pooled estimate of the effect of cognitive strategy training using Review Manager 5.1 software (The Nordic Cochrane Centre, 2014). As different outcome measures were used across studies, the effect size was reported as Cohen's standardised mean difference (SMD) with a 95% confidence interval (CI). A random effects model was used and where the heterogeneity of effects was significant ($I^2 >$ 50%), a sensitivity analysis was carried out to confirm the source of heterogeneity. Where there were sufficient comparible studies, subgroup analyses were planned a priori to examine the effect of cognitive strategy intervention approaches for a stroke only population and timing of intervention delievery (subacute versus chronic).

Results

Flow of studies through the review

The search strategy identified 4112 studies. After duplicates were removed, titles and abstracts of 2846 studies were screened. The full text of 123 potentially eligible studies were retrieved. Eighty-two studies did not meet the inclusion criteria; Figure 1 provides an overview of the flow of studies through the review.

Forty-one studies were included in the content analysis. Tables 3 and 4 summarise the method of each study and the methodological quality and level of evidence ratings. Twenty studies provided level II evidence (good quality randomised controlled trials (RCT)) (Ahn et al., 2017; Ahn, 2019; Bertens et al., 2015; Bertilsson et al., 2014; Donkervoort et al., 2001; Geusgens et al., 2006; Goverover et al., 2007; Guidetti et al., 2010; Guidetti and Ytterberg, 2011; Guidetti et al., 2015; Kessler et al., 2017; Liu et al., 2004a; Liu and Chan, 2014; McEwen et al., 2015; Ownsworth et al., 2008; Polatajko et al., 2012; Skidmore et al., 2015; Song et al., 2019; Spikman et al., 2010; Winkens et al., 2009), two studies provided level III-1 evidence (quasi-RCT) (Dawson et al., 2013; Poulin et al., 2017). Of the remaining studies, two studies provided level III-2 evidence (comparative group studies with controls) (Miotto et al., 2009; Novakovic-Agopian et al., 2011), three studies provided level III-3 evidence (comparative group study without control) (Geusgens et al., 2007a; van Heugten et al., 1998; Skidmore et al., 2014) and fourteen provided level IV evidence (case series or case reports) (Dawson et al., 2009; Grant et al., 2012; Henshaw et al., 2011; Kessler et al., 2014; Landa-Gonzalez, 2001; Liu et al., 2002; Liu et al., 2004b; McEwen et al., 2009b; McEwen et al., 2010; McEwen et al., 2017; Ng et al., 2013; Nott et al., 2008; Skidmore et al., 2011; Toglia et al., 2010).

Of the 22 RCTs and quasi-RCTs, 16 were included in the meta-analysis (Ahn et al., 2017; Ahn, 2019; Bertilsson et al., 2014; Dawson et al., 2013; Donkervoort et al., 2001; Goverover et al., 2007; Kessler et al., 2017; Liu et al., 2004a; Liu and Chan, 2014; McEwen et al., 2015; Polatajko et al., 2012; Poulin et al., 2017; Skidmore et al., 2015; Song et al., 2019; Spikman et al., 2010; Winkens et al., 2009). Six studies were not included for the following reasons. Guidetti et al. (2010) reported median and interquartile range and subsequently data could not be pooled in the meta-analysis. Two studies presented long-term outcomes from previously reported trials (Guidetti and Ytterberg, 2011; Guidetti et al., 2015) and one study conducted additional analysis of data from the original trial (Geusgens et al., 2006). Where possible data from these studies were analysed together with the original study. Two studies compared cognitive strategy interventions in both intervention and control conditions (Bertens et al., 2015; Ownsworth et al., 2008). Consequently, these studies were not included in the meta-analysis.

Characteristics of included studies

Methodological quality

Of the sixteen level II and III-1 studies included in the quantitative analysis, PEDro scores ranged from 3 to 8 with a mean of 6.2 (SD 1.4) (Table 5). All trials reported statisical comparisons of treatment and control groups and point estimate variability. The majority of trials met the criteria for random allocation (88%), blinding of assessors (69%), baseline similarity (88%) and achieving adequate follow-up (75%). Seven (44%) trials reported using intention-to-treat analysis. One paper reported participant blinding.

Participants

The included trials recruited 889 participants, 811 (91%) of whom completed post-intervention assessment (Table 3). Sample sizes varied considerably across trials; five studies (31%) recruited sample sizes of less than 25 participants, eight (50%) studies recruited sample sizes of less than 50 participants, one study (6%) recruited less than 100 participants and only two studies (12%) involved sample sizes greater than 100 participants. Overall, studies included 796 (91%) participants with stroke, 65 (7%) with TBI and 10 (1%) were diagnosed with other causes of neurological injury (for example, post-revision of low-grade brain tumour). Participants were predominantly working age adults with the mean age of participants ranging from 39 to 72 years. The length of time since onset of neurological condition ranged from under 7 days to 10 years.

Intervention

Ten different cognitive strategy interventions were used across included trials (Table 3): client-centred activities of daily living intervention (Bertilsson et al., 2014), Cognitive Orientation to daily Occupational Performance (Ahn et al., 2017; Dawson et al., 2013;

McEwen et al., 2015; Polatajko et al., 2012; Poulin et al., 2017; Song et al., 2019), metacognitive strategy training (Goverover et al., 2007), multifaceted strategy training (Spikman et al., 2010), occupation-based intervention (Ahn, 2019), Occupational Performance Coaching-Stroke (Kessler et al., 2017), self-regulation for promoting function (Liu et al., 2004a; Liu and Chan, 2014), strategy training (Skidmore et al., 2015), strategy training for apraxia (Donkervoort et al., 2001) and Time Pressure Management (Winkens et al., 2009). Interventions were predominantly delivered in the outpatient or inpatient rehabilitation settings, and only provided in the participants' home or relevant community settings in three studies. Cognitive strategy interventions were delivered by an occupational therapist in 10 (63%) studies, trained rehabilitation personnel or therapists in 4 (25%) studies, by either an occupational therapist or neurpsychologist in 1 (6%) study and by a neuropsychologist in 1 (6%) study. The intensity (min/session), frequency (days/week) and overall duration (weeks) of intervention varied across studies. Interventions ranged from 30-minute sessions to 120-minute sessions, at varied frequencies of between one to five days per week, with an intervention duration from one to sixteen weeks.

Comparison interventions

Most studies compared cognitive strategy training with a comparable control intervention (Table 3). Comparative interventions included 'standard' or 'usual' occupational therapy (Ahn et al., 2017; Bertilsson et al., 2014; Donkervoort et al., 2001; Liu et al., 2004a; Liu and Chan, 2014; Polatajko et al., 2012), attention control in addition to usual care (Skidmore et al., 2015), usual care without (no) occupational therapy (Kessler et al., 2017), action focusing intervention (Ahn, 2019), task-specific retraining (Song et al., 2019), conventional task practice or functional retraining (Goverover et al., 2007), conventional cognitive rehabilitation (Winkens et al., 2009) and computer-based cognitive retraining (Poulin et al., 2017; Spikman et al., 2010). Only one study used a no intervention control group (Dawson et al., 2013). The majority of studies provided limited information detailing the procedures and contents of comparator interventions.

Outcome measures

Performance of activities of daily living was measured using a variety of outcome measures (Table 3) including: Canadian Occupational Performance Measure Performance scale (8 comparisons), Treatment Goal Achievement Scale (1 comparison), the Barthel Activity of Daily Living index (4 comparisons), the Functional Independence Measure (3 comparisons), Assessment of Motor and Process Skills (3 comparisons), ADL observations (1 comparisons), everyday task performance rating (1 comparison), Everyday Information Intake Task (1 comparison), Performance Quality Rating Scale (4 comparisons), Katz Activity of Daily Living Inventory (1 comparison) and Frenchay Activities Index (1 comparison). Due to the heterogeneity of outcome measures, it was not possible to include all outcomes in the analyses. Outcomes were measured immediately post-intervention in fourteen studies. Post-intervention outcome assessment was conducted at two to three months in three studies. Follow-up data was presented in seven studies and the time interval varied from one to twelve months.

Intervention effects

To quantify effects of cognitive strategy training we conducted separate random-effects meta-analyses to understand activity performance outcomes for all participants, and for stroke-only participants which allowed determination of response variation across populations, and for timing of the intervention delivery.

Activity performance outcomes: all cognitive strategy training approaches

The immediate effect of cognitive strategy training compared to any other comparitive intervention or no intervention was examined using a random effects model from sixteen studies, involving 833 participants with non-progressive brain injury (Ahn et al., 2017; Ahn, 2019; Bertilsson et al., 2014; Dawson et al., 2013; Donkervoort et al., 2001; Goverover et al., 2007; Kessler et al., 2017; Liu et al., 2004a; Liu and Chan, 2014; McEwen et al., 2015; Polatajko et al., 2012; Poulin et al., 2017; Skidmore et al., 2015; Song et al., 2019; Spikman et al., 2010; Winkens et al., 2009). Cognitive strategy training improved activity performance outcomes for participants immediately after the intervention period (SMD = 0.79, 95% CI 0.49 to 1.09) (Figure 2). There was substantial statistical heterogeneity ($I^2 = 72\%$, $p < 0.00001$), indicating the variation between results of the trials was above the variation expected by chance. A sensitivity analysis revealed that the heterogeneity was not explained by differences in the methodological quality of included trials, use of estimated values where studies had provided incomplete data, differences in cognitive strategy interventions used nor differences in the timing of intervention delievery.

Seven studies, with 269 participants, presented follow-up data (i.e. > 4 weeks and < 12 months following post-intervention assessment) for this same comparison (Donkervoort et al., 2001; Kessler et al., 2017; McEwen et al., 2015; Poulin et al., 2017; Skidmore et al., 2015; Spikman et al., 2010; Winkens et al., 2009) . Cognitive strategy training improved activity performance compared with usual care at the follow-up timepoint (SMD 0.41, 95% CI 0.13 to 0.70) (Figure 3), with low heterogeneity ($I^2 = 17\%$) amongst studies.

Activity performance outcomes: stroke participants only

The effect of cognitive strategy training for people diagnosed with stroke was examined by pooling post intervention data from 13 studies, with 725 participants. Of these, five trials were conducted in early stage rehabilitation (less than three months since onset) (Bertilsson et al., 2014; Liu et al., 2004a; Liu and Chan, 2014; McEwen et al., 2015; Skidmore et al., 2015), seven were conducted in the chronic phase of rehabilitation (greater than three months following stroke) in outpatient or community rehabilitation settings (Ahn et al., 2017; Ahn, 2019; Kessler et al., 2017; Polatajko et al., 2012; Poulin et al., 2017; Song et al., 2019; Winkens et al., 2009), and one study offered the intervention to participants within two years of stroke onset in either inpatient rehabilitation or a nursing home setting (Donkervoort et al., 2001). Cognitive strategy training improved activity performance in stroke participants compared to usual or standard care (SMD 0.75, 95% CI 0.41 to 1.10) (Figure 4), however heterogeneity between studies was high ($I^2=74\%$, $p < 0.00001$).

Timing of providing cognitive strategy interventions

The effect of cognitive strategy training conducted in an early phase of rehabilitation (less than three months from onset) compared with usual care was examined by pooling post-intervention data from five studies, with 426 participants (Bertilsson et al., 2014; Liu et al., 2004a; Liu and Chan, 2014; McEwen et al., 2015; Skidmore et al., 2015). Cognitive strategy training improved activity performance compared to usual or standard care (SMD 0.63, 95% CI 0.07 to 01.19), however again, heterogeneity was high ($I^2 = 80\%$). The effect of cognitive strategy training conducted in the chronic stage of recovery (greater than three months from onset) was explored by pooling data from ten studies with 314 participants (Ahn et al., 2017; Ahn, 2019; Dawson et al., 2013; Goverover et al., 2007; Kessler et al., 2017; Polatajko et al., 2012; Poulin et al., 2017; Song et al., 2019; Spikman et al., 2010; Winkens et al., 2009). Results also favoured cognitive strtaegy training (SMD 0.95, 95% CI 0.59 to 1.32); heterogeneity between studies was moderate ($I^2 = 49\%$).

Discussion

This systematic review sought to understand the benefit of using a cognitive strategy training approach to improve activity performance for adults with non-progressive neurological conditions, including traumatic brain injury and stroke. While different cognitive strategy training approaches were identified across studies, there was sufficient similarity between intervention approaches to permit meta-analysis. Our findings indicate that cognitive strategy training resulted in greater improvements in activity performance when compared to conventional or standard care, which mostly included occupational therapy of unspecified dose or approach.

While we report a positive effect for cognitive strategy training in improving activity performance, these findings need to be interpreted with caution. Many of the included studies were limited by small sample sizes that did not have sufficient power to detect clinically meaningful effects of intervention. Furthermore, there was considerable variability between studies in outcome measures used to measure changes in activity performance, as well as the timing and intensity of cognitive strategy interventions. Taking all this into account, our conclusion is that the evidence-base for cognitive strategy training is currently insufficient and no strong conclusions can be drawn to guide clinical practice.

Limited consensus exists in the rehabilitation literature on the most appropriate outcome measures to measure changes in activity performance and participation for adults with neurological conditions and considerable variability was evident in the outcome measures used across included studies. Many existing studies used outcome assessments limited to self-care performance outcomes or used observational measures of activity performance with limited psychometric properties. Consistent with the review of Chung and colleagues (2013), our review applied their stricter definition of activity performance and we did not include measures of error frequency (e.g. number of errors made during task performance) or completion of steps (e.g. ommission of essential task steps or addition of unnecessary steps) as a measure of activity performance,instead appraising these outcomes as being at the body function and structures level of the International Classification of Functioning, Disability and Health (ICF) (World Health Organization, 2001). It remains unclear to what extent changes on these outcomes reflect actual improvements in everyday task performance (Cramm et al., 2016). The primary goal of rehabilitation is to improve the individual's ability to participate in meaningful everyday activities. It is essential therefore that future studies use outcome measures that more accurately reflect performance of a broader range of everyday tasks that are relevant and meaningful to individuals with neurological conditions, for example the Canadian Occupational Performance Measure (Law, 2014) or the Assessment of Motor and Process Skills (Fisher and Jones, 2012).

The optimal timing of cognitive strategy training is not currently well understood and variability in the timing of intervention across studies was evident. Our review included studies conducted in all stages of rehabilitation, from acute inpatient to chronic community rehabilitation settings. Only one included study recruited participants in the subacute stage of rehabilitation (McEwen et al., 2015). This is surprising given that there is consensus that rehabilitation provided early following neurological injury has a greater effect on longer term functional outcomes (Wolf et al., 2015) . This an important gap that needs to be addressed by future research.

There was considerable variability in how cognitive strategy training interventions were delivered with respect to intensity, frequency and duration across the trials. Cognitive strategy training interventions were also inconsistently conducted in conjunction with other occupational therapy and/or psychology treatments. As such, we are unable to comment on optimal protocols or doses for cognitive strategy training. Many studies lacked detail about the content of conventional or standard care being compared to cognitive strategy training interventions and few studies published an intervention guide or protocol that would facilitate replication. We acknowledge the improvement in study reporting with the release of the updated CONSORT statement (2010) and the TIDieR checklist as an extension of the CONSORT statement (Hoffmann et al., 2014). Future trials must adhere to these reporting recommendations to enable future synthesis and allow for accurate comparisons, as well as researchers and clinicians alike to be able to understand the nature of the interventions delivered. This is important to enable clinicians to make informed decisions on the suitability of cognitive strategy training for their client population and clinical setting.

Every effort was made throughout all stages of the systematic review to limit potential sources of bias. However, there are some limitations that need to be considered when interpreting findings. The meta-analysis may have been affected by small study bias; over one-third (36%) of studies included a sample size of less than 25 participants per study. We additionally experienced incomplete data reporting in included studies. Consequentially, data were estimated statistically which may impact on the precision of pooled results.

Implications for practice and future research

Limited evidence currently exists regarding the effectiveness of cognitive strategy interventions for improving activity performance for adults with non-progressive neurological conditions, such as brain injury or stroke. No strong conclusions can be drawn to guide occupational therapy practice on the optimal cognitive strategy intervention approach or on dosage, intensity or timing of cognitive strategy intervention approaches. Larger, well-conducted randomised controlled trials that eliminate potential risks of bias are required to provide stronger evidence to support the use of cognitive strategy training. It is important that the feasibility and acceptability of future randomised controlled trials be carefully considered to ensure that a sufficient number of participants can be recruited to and retained within the trial. In addition, researchers should use objective and methodologically robust outcome measures of activity and performance. Furthermore, there is a need to consider participants' perspectives on the acceptability and suitability of cognitive strategy training interventions. This is an area that is largely unexplored and requires consideration because participants perspectives are likely to influence levels of engagement and may even influence the potential success of interventions (Gillespie et al., 2015).

Key findings

- Cognitive strategy training approaches demonstrated a positive benefit on activity performance for adults with non-progressive neurological conditions compared to conventional or standard care, but the strength of these findings are limited by high degree of variability between studies.
- No strong conclusions can be drawn to guide clinical practice on the optimal approach or dosage, intensity or timing of intervention delivery.
- More high quality research is needed to determine the efficacy of cognitive strategy training interventions on improving activity performane and participation.

What the study has added

This systematic review presented the current evidence on cognitive strategy interventions for improving activity performance in adults with non-progressive neurological conditions. Future research should better define comparsion interventions, include a larger sample size and use objective and methodologically robust measures of activity performance and participation.

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Figure 1. Flow of studies through the systematic review

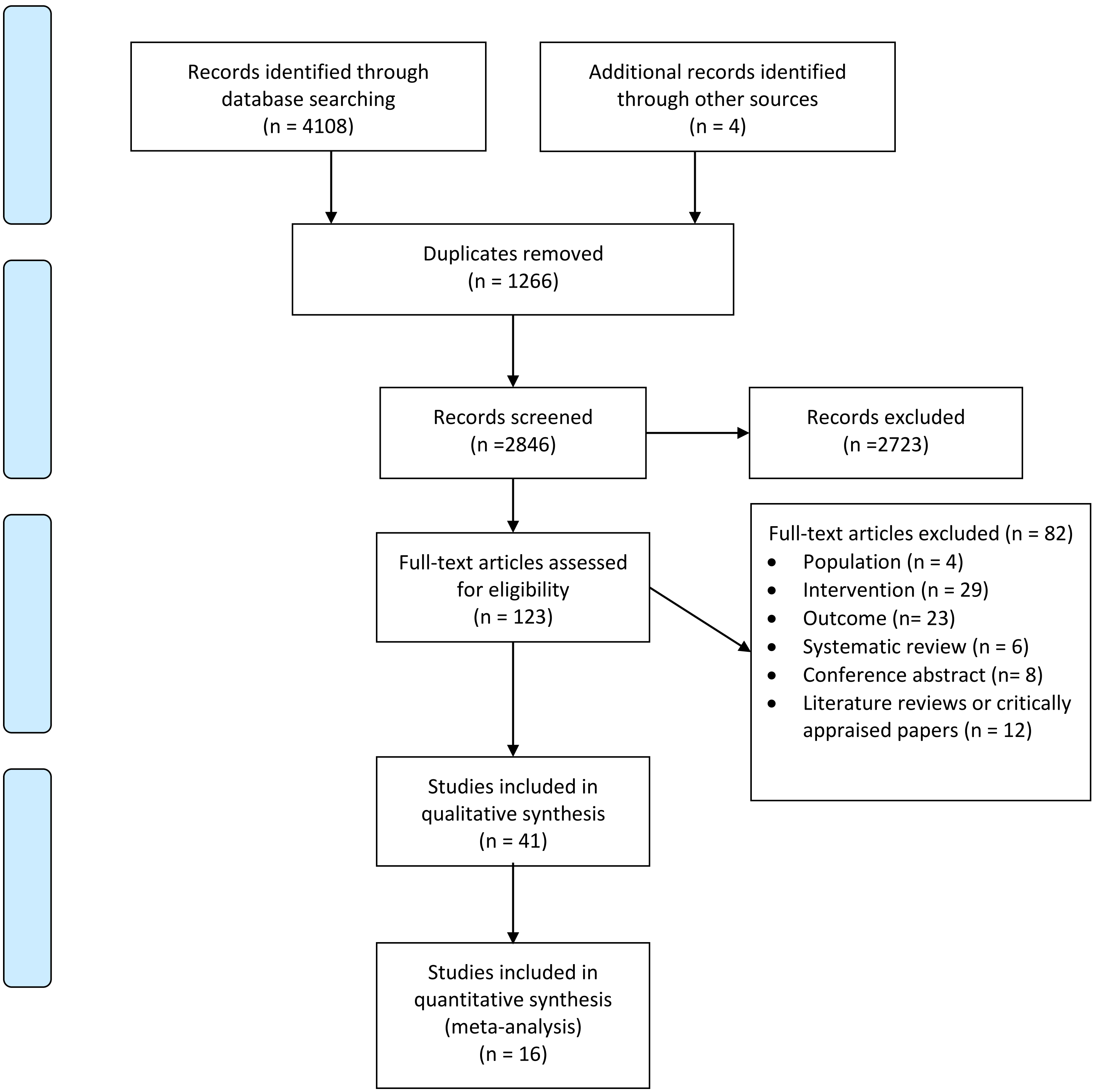

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Figure 2. SMD (95% CI) of the effect of cognitive strategy training compared with any comparative intervention or no intervention on activity performance outcomes immediately after intervention for people with non-progressive brain injury.

	Experimental			Control				Std. Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Random, 95% CI**
Ahn 2017*	7.55	1.1357	20	5.35	1.3253	23	6.5%	1.74 [1.03, 2.45]
Ahn 2019	4.7	0.6	23	4.5	0.4	20	7.3%	0.38 [-0.23, 0.98]
Bertilsson 2014*	81.7	20.2156	129	77.7	20.2156	151	9.7%	0.20 [-0.04, 0.43]
Dawson 2013	2	1.58	7	0.2	1.07	6	3.8%	1.22 [-0.01, 2.45]
Donkervoort 2001*	2.44	2.9744	45	1.15	2.4567	48	8.6%	0.47 [0.06, 0.88]
Goverover 2007	0.87	0.2	10	0.64	0.35	10	5.3%	0.77 [-0.14, 1.69]
Kessler 2017	2.67	1.89	8	1.38	1.65	11	5.1%	0.70 [-0.24, 1.65]
Liu 2004	5.3	1	26	4	0.9	20	7.0%	1.33 [0.68, 1.98]
Liu 2014*	23	9.019	24	14	9.019	20	7.1%	0.98 [0.35, 1.61]
McEwen 2015	1.5	3	14	2.3	2.1	12	6.1%	-0.30 [-1.07, 0.48]
Polatajko 2012	4.3	0.6	4	1.3	2.2	4	2.2%	1.62 [-0.16, 3.40]
Poulin 2017*	7.1	1.3	5	8	1.4	4	3.3%	-0.60 [-1.96, 0.77]
Skidmore 2015	44.65	10.3796	15	29.91	17.5059	15	6.2%	1.00 [0.23, 1.76]
Song 2019	5.21	1.47	25	2.89	1.47	24	7.0%	1.55 [0.91, 2.20]
Spikman 2010	10.4	2.5	38	8.2	1.8	37	8.2%	1.00 [0.52, 1.48]
Winkens 2009	0.4	0.9336	19	-0.3	0.7507	16	6.7%	0.80 [0.11, 1.49]
Total (95% CI)			**412**			**421**	**100.0%**	**0.79 [0.49, 1.09]**

Heterogeneity: $Tau^2 = 0.23$; $Chi^2 = 51.06$, $df = 15$ ($P < 0.00001$); $I^2 = 71\%$

Test for overall effect: $Z = 5.14$ ($P < 0.00001$)

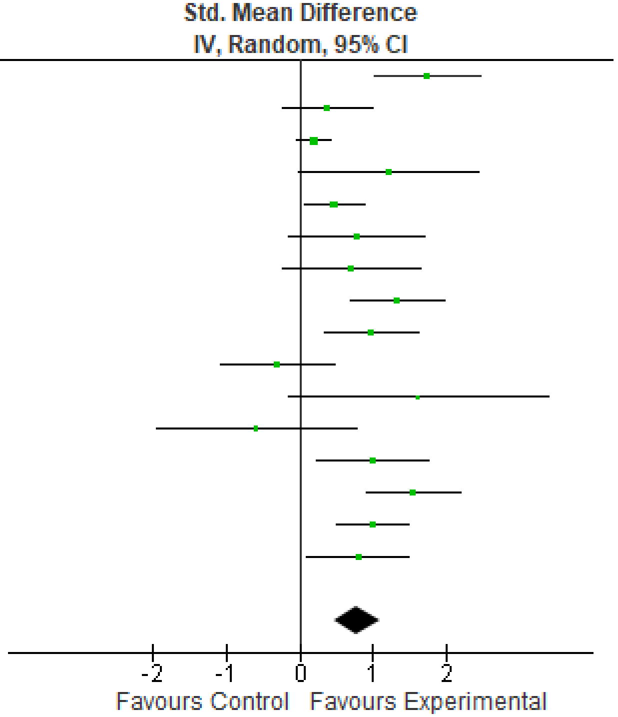

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Figure 3: SMD (95% CI) of the effect of cognitive strategy training compared with any comparative intervention or no intervention on activity performance outcomes at follow-up time point for people with non-progressive brain injury

	Experimental			Control				Std. Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Random, 95% CI**
Donkervoort 2001*	3	4.0157	43	2.83	3.0968	40	28.4%	0.05 [-0.38, 0.48]
Kessler 2017	2.386	1.305	6	1.092	2.7191	11	7.0%	0.52 [-0.49, 1.54]
McEwen 2015	2.9	1.8	13	2.3	2.5	9	9.5%	0.27 [-0.58, 1.13]
Poulin 2017*	6.9	1.4	5	6.7	2.5	4	4.3%	0.09 [-1.22, 1.41]
Skidmore 2015	48.27	10.3796	15	32.12	18.51286	15	11.5%	1.05 [0.28, 1.82]
Spikman 2010	10.7	2.1	37	8.9	3	38	25.4%	0.69 [0.22, 1.15]
Winkens 2009	0.1	0.6807	17	-0.1	0.6568	16	13.9%	0.29 [-0.40, 0.98]
Total (95% CI)			**136**			**133**	**100.0%**	**0.41 [0.13, 0.70]**

Heterogeneity: Tau² = 0.02; Chi² = 7.19, df = 6 (P = 0.30); I² = 17%
Test for overall effect: Z = 2.90 (P = 0.004)

Std. Mean Difference
IV, Random, 95% CI

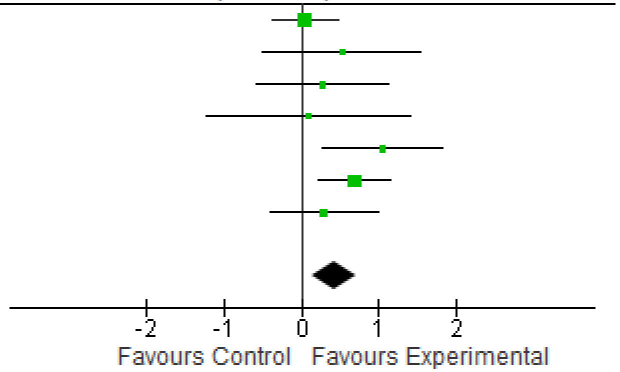

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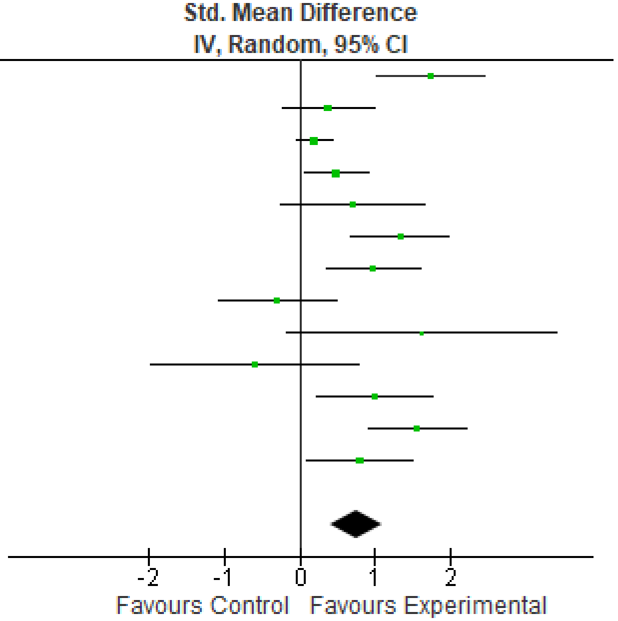
Figure 4. SMD (95% CI) of the effect of cognitive strategy training compared with any comparative intervention on activity performance outcomes immediatey after intervention for people with stroke.

	Experimental			Control				Std. Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Random, 95% CI**
Ahn 2017*	7.55	1.1357	20	5.35	1.3253	23	7.9%	1.74 [1.03, 2.45]
Ahn 2019	4.7	0.6	23	4.5	0.4	20	8.7%	0.38 [-0.23, 0.98]
Bertilsson 2014*	81.7	20.2156	129	77.7	20.2156	151	11.2%	0.20 [-0.04, 0.43]
Donkervoort 2001*	2.44	2.9744	45	1.15	2.2457	48	10.2%	0.49 [0.07, 0.90]
Kessler 2017	2.67	1.89	8	1.38	1.65	11	6.3%	0.70 [-0.24, 1.65]
Liu 2004	5.3	1	26	4	0.9	20	8.4%	1.33 [0.68, 1.98]
Liu 2014*	23	9.019	24	14	9.019	20	8.5%	0.98 [0.35, 1.61]
McEwen 2015	1.5	3	14	2.3	2.1	12	7.5%	-0.30 [-1.07, 0.48]
Polatajko 2012	4.3	0.6	4	1.3	2.2	4	2.9%	1.62 [-0.16, 3.40]
Poulin 2017*	7.1	1.3	5	8	1.4	4	4.2%	-0.60 [-1.96, 0.77]
Skidmore 2015	44.65	10.3796	15	29.91	17.5059	15	7.5%	1.00 [0.23, 1.76]
Song 2019	5.21	1.47	25	2.89	1.47	24	8.4%	1.55 [0.91, 2.20]
Winkens 2009	0.4	0.9336	19	-0.3	0.7507	16	8.1%	0.80 [0.11, 1.49]
Total (95% CI)			**357**			**368**	**100.0%**	**0.75 [0.41, 1.10]**

Heterogeneity: Tau² = 0.27; Chi² = 46.92, df = 12 (P < 0.00001); I² = 74%
Test for overall effect: Z = 4.24 (P < 0.0001)



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