TECHNICAL COMMENTARY

Memory

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Introduction

Memory involves encoding, storage and retrieval of information. Short-term memory is the ability to remember information after several seconds or minutes; and long-term memory is the ability to remember information over a longer duration. Semantic memory is memory for general facts, episodic memory is memory for personal events, prospective memory is memory for future actions, and retrospective memory is memory for past events. Working memory involves information being temporarily held as well as manipulated.

Method

We have included only systematic reviews (systematic literature search, detailed methodology with inclusion/exclusion criteria) published in full text, in English, from the year 2010 that report results separately for people with PTSD. Reviews were identified by searching the databases MEDLINE, EMBASE, and PsycINFO. When multiple copies of reviews were found, only the most recent version was included. We prioritised reviews with pooled data for inclusion.

Review reporting assessment was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist that describes a preferred way to present a meta-analysis[1]. Reviews with less than 50% of items checked have been excluded from the library. Note that early reviews may have been guided by less stringent reporting checklists than the PRISMA, and that some reviews may have been limited by journal guidelines.

Evidence was graded using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group approach where high quality evidence such as that gained from randomised controlled trials (RCTs) may be downgraded to moderate or low if review and study quality is limited, if there is inconsistency in results, indirect comparisons, imprecise or sparse data and high probability of reporting bias. It may also be downgraded if risks associated with the intervention or other matter under review are high. Conversely, low quality evidence such as that gained from observational studies may be upgraded if effect sizes are large or if there is a dose dependent response. We have also taken into account sample size and whether results are consistent, precise and direct with low associated risks (see end of table for an explanation of these terms)[2]. The resulting table represents an objective summary of the available evidence, although the conclusions are solely the opinion of staff of NeuRA (Neuroscience Research Australia).

Results

We found five systematic reviews that met our inclusion criteria[3-7].

- Moderate quality evidence finds small to medium-sized effects that people with PTSD had poorer memory than controls. The effect size was larger for verbal memory than for visual memory.
- Moderate to high quality evidence finds medium to large effects of poorer verbal episodic and working memory in people with PTSD, with similar effects found in children and adults. Visual episodic memory was impaired only in children with PTSD.
- Moderate to high quality evidence finds a medium-sized effect of poorer prospective memory in people with PTSD than controls.
- Moderate to high quality evidence found a medium to large effect of poorer memory ability in older people (>65 years) with PTSD.
- Moderate to low quality evidence finds large deficits in autobiographical memory in people with PTSD.

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Masson M, East-Richard C, Cellard C

A meta-analysis on the impact of psychiatric disorders and maltreatment on cognition

Neuropsychology 2016; 30: 143-56

View review abstract online

Comparison	**Episodic and working memory in people with PTSD vs. controls.**
Summary of evidence	**Moderate to high quality evidence (mixed samples, mostly inconsistent, precise, direct) finds medium to large effects of poorer verbal episodic and working memory in people with PTSD, with similar effects found in children and adults. Visual episodic memory was impaired only in children with PTSD.**
Episodic and working memory	
Medium to large effects showed people with PTSD had poorer memory on; Verbal episodic memory tasks: 23 studies, N = 858, *g* = -0.71, 95%CI -0.87 to -0.55, *p* < 0.0001, Q = 30.28, *p* = 0.112 Working memory tasks: 4 studies, N = 173, *g* = -0.36, 95%CI -0.65 to -0.06, *p* = 0.018, Q = 0.31, *p* = 0.957 *There were no significant differences on;* Visual episodic memory tasks: 17 studies, N = 713, *g* = -0.20, 95%CI -0.45 to 0.06, *p* = 0.132, Q = 46.99, *p* < 0.0001 Subgroup analyses of age (7-17 vs. 18+ years) showed similar effect sizes for verbal and working memory. Visual memory showed a large effect of poorer task performance in children vs. controls.	
Consistency in results‡	Consistent for working memory only.
Precision in results§	Precise
Directness of results‖	Direct

Ono M, Devilly GJ, Shum DH

A meta-analytic review of overgeneral memory: The role of trauma history, mood, and the presence of posttraumatic stress disorder

Psychological Trauma: Theory, Research, Practice and Policy 2016; 8: 157-64

View review abstract online

Comparison	**Autobiographical memory in people with PTSD vs. controls.**
Summary of evidence	**Moderate to low quality evidence (small samples, inconsistent, imprecise, direct) finds large deficits in autobiographical memory in people with PTSD than controls.**
Autobiographical memory	
Large effects of autobiographical memory deficits in people with PTSD in; Overall specific memories: 4 studies, N = 181, g = 1.91, 95%CI 0.75 to 3.08, $p < 0.01$, I^2 = 95% Specific positive memories: 3 studies, N = 128, g = 1.21, 95%CI 0.51 to 1.90, $p < 0.05$, I^2 = 70% Specific negative memories: 3 studies, N = 128, g = 1.08, 95%CI 0.27 to 1.89, $p < 0.05$, I^2 = 78% Overall general memories: 5 studies, N = 222, g = 1.30, 95%CI 0.62 to 1.97, $p < 0.01$, I^2 = 88% Specific general memories: 4 studies, N = 169, g = 0.90, 95%CI 0.57 to 1.22, $p < 0.05$, I^2 = 71% Specific general memories: 4 studies, N = 169, g = 1.09, 95%CI 0.51 to 1.67, $p < 0.05$, I^2 = 67% Authors explain an autobiographical memory deficit in PTSD as having difficulty recalling specific details of personal events and a tendency to recall an overall, general impression of events instead.	
Consistency in results	Inconsistent
Precision in results	Imprecise
Directness of results	Direct

Piefke M, Glienke K

The effects of stress on prospective memory: A systematic review

Psychology and Neuroscience 2017; 10: 345-62

View review abstract online

Comparison	**Prospective memory in people with PTSD vs. controls (mostly trauma exposed).**
Summary of evidence	**Moderate to high quality evidence (small sample, consistent, precise, direct) finds a medium-sized effect of poorer prospective memory in people with PTSD than controls.**
Prospective memory	
A medium-sized effect of poorer prospective memory in people with PTSD; 5 studies, N = 210, g = -0.58, 95%CI -0.67 to -0.49, $p < 0.05$, Q$p > 0.05$	

Consistency in results	Consistent
Precision in results	Precise
Directness of results	Direct

Schuitevoerder S, Rosen JW, Twamley EW, Ayers CR, Sones H, Lohr JB, Goetter EM, Fonzo GA, Holloway KJ, Thorp SR

A meta-analysis of cognitive functioning in older adults with PTSD

Journal of Anxiety Disorders 2013; 27: 550-8

View review abstract online

Comparison	**Memory in older people with PTSD (>65 years) vs. controls.**
Summary of evidence	**Moderate to high quality evidence (small sample, consistent, precise, direct) found a medium to large effect of poorer memory ability in older people with PTSD compared to controls.**

Memory

A medium to large effect showed poorer memory ability in people with PTSD:

3 studies, N = 140, g = -0.73, 95%CI -1.02 to -0.44, $p < 0.05$, $I^2 = 0\%$

There was no significant difference between trauma-exposed PTSD and trauma-exposed no PTSD.

Consistency in results	Consistent
Precision in results	Precise
Directness of results	Direct

Scott JC, Matt GE, Wrocklage KM, Crnich C, Jordan J, Southwick SM, Krystal JH, Schweinsburg BC

A quantitative meta-analysis of neurocognitive functioning in posttraumatic stress disorder

Psychological Bulletin 2015; 141: 105-40

View review abstract online

Comparison	**Memory ability in people with PTSD vs. controls.**

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Summary of evidence	**Moderate quality evidence (unclear sample size, unable to assess consistency, precise, direct) finds small to medium-sized effects showed people with PTSD had poorer verbal and visual memory than controls. The effect size was larger for verbal memory than for visual memory.**
Memory	
Small to medium-sized effects showed people with PTSD had poorer memory than controls; Verbal memory: 65 studies, N = unclear, *g* = -0.48, 95%CI -0.58 to -0.35, $p < 0.05$, I^2 not reported Visual memory: 52 studies, N = unclear, *g* = -0.29, 95%CI -0.40 to -0.19, $p < 0.05$, I^2 not reported	
Consistency in results	Unable to assess; no measure of consistency is reported.
Precision in results	Precise
Directness of results	Direct

Explanation of acronyms

CI = confidence interval, *d, g* = Cohen's d and Hedges' g, standardised mean differences, I^2 = the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (chance), N = number of participants, Q = measure of heterogeneity, *p* = statistical probability of obtaining a result, vs. = versus

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Explanation of technical terms

* Bias has the potential to affect reviews of both RCT and observational studies. Forms of bias include; reporting bias – selective reporting of results; publication bias - trials that are not formally published tend to show less effect than published trials, further if there are statistically significant differences between groups in a trial, these trial results tend to get published before those of trials without significant differences; language bias – only including English language reports; funding bias - source of funding for the primary research with selective reporting of results within primary studies; outcome variable selection bias; database bias - including reports from some databases and not others; citation bias - preferential citation of authors. Trials can also be subject to bias when evaluators are not blind to treatment condition and selection bias of participants if trial samples are small[8].

† Different effect measures are reported by different reviews.

Prevalence refers to how many existing cases there are at a particular point in time. Incidence refers to how many new cases there are per population in a specified time period. Incidence is usually reported as the number of new cases per 100,000 people per year. Alternatively some studies present the number of new cases that have accumulated over several years against a person-years denominator. This denominator is the sum of individual units of time that the persons in the population are at risk of becoming a case. It takes into account the size of the underlying population sample and its age structure over the duration of observation.

Reliability and validity refers to how accurate the instrument is. Sensitivity is the proportion of actual positives that are correctly identified (100% sensitivity = correct identification of all actual positives) and specificity is the proportion of negatives that are correctly identified (100% specificity = not identifying anyone as positive if they are truly not).

Weighted mean difference scores refer to mean differences between treatment and comparison groups after treatment (or occasionally pre to post treatment) and in a randomised trial there is an assumption that both groups are comparable on this measure prior to treatment. Standardised mean differences are divided by the pooled standard deviation (or the standard deviation of one group when groups are homogenous) that allows results from different scales to be combined and compared. Each study's mean difference is then given a weighting depending on the size of the sample and the variability in the data. Less than 0.4 represents a small effect, around 0.5 a medium effect, and over 0.8 represents a large effect[8].

Odds ratio (OR) or relative risk (RR) refers to the probability of a reduction (< 1) or an increase (> 1) in a particular outcome in a treatment group, or a group exposed to a risk factor, relative to the comparison group. For example, a RR of 0.75 translates to a reduction in risk of an outcome of 25% relative to those not receiving the treatment or not exposed to the risk factor. Conversely, a RR of 1.25 translates to an increased risk of 25% relative to those not receiving treatment or not having been exposed to a risk factor. A RR or OR of 1.00 means there is no difference between groups. A medium effect is considered if RR > 2 or < 0.5 and a large effect if RR > 5 or < 0.2[9]. lnOR stands for logarithmic OR where a lnOR of 0 shows no difference between groups. Hazard ratios measure the effect of an explanatory variable on the hazard or risk of an event.

Correlation coefficients (eg, r) indicate the strength of association or relationship

between variables. They can provide an indirect indication of prediction, but do not confirm causality due to possible and often unforseen confounding variables. An r of 0.10 represents a weak association, 0.25 a medium association and 0.40 and over represents a strong association. Unstandardised (*b*) regression coefficients indicate the average change in the dependent variable associated with a 1 unit change in the independent variable, statistically controlling for the other independent variables. Standardised regression coefficients represent the change being in units of standard deviations to allow comparison across different scales.

‡ Inconsistency refers to differing estimates of effect across studies (i.e. heterogeneity or variability in results) that is not explained by subgroup analyses and therefore reduces confidence in the effect estimate. I^2 is the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (chance) - 0% to 40%: heterogeneity might not be important, 30% to 60%: may represent moderate heterogeneity, 50% to 90%: may represent considerable heterogeneity and over this is considerable heterogeneity. I^2 can be calculated from Q (chi-square) for the test of heterogeneity with the following formula[8];

$$I^2 = \left(\frac{Q - df}{Q}\right) \times 100\%$$

§ Imprecision refers to wide confidence intervals indicating a lack of confidence in the effect estimate. Based on GRADE recommendations, a result for continuous data (standardised mean differences, not weighted mean differences) is considered imprecise if the upper or lower confidence limit crosses an effect size of 0.5 in either direction, and for binary and correlation data, an effect size of 0.25. GRADE also recommends downgrading the evidence when sample size is smaller than 300 (for binary data) and 400 (for continuous data), although for some topics, these criteria should be relaxed[10].

‖ Indirectness of comparison occurs when a comparison of intervention A versus B is not available but A was compared with C and B was compared with C that allows indirect comparisons of the magnitude of effect of A versus B. Indirectness of population, comparator and/or outcome can also occur when the available evidence regarding a particular population, intervention, comparator, or outcome is not available and is therefore inferred from available evidence. These inferred treatment effect sizes are of lower quality than those gained from head-to-head comparisons of A and B.

Margarete Ainsworth Building, Barker Street, Randwick NSW 2031. Phone: 02 9399 1000. Email: info@neura.edu.au

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