

## Effect Sizes For Group Differences

**Background & Purpose:** Reviews<sup>1,2</sup> suggest chronic pain is likely to be associated with weaknesses, relative to control groups, in at least some cognitive functions including processing speed, attention, and possibly working memory, but differences between studies obscure the size of effects. This study provided a quantitative analysis of the magnitude of the association between chronic pain and neurocognitive test performances.

**Methods:** Meta-analysis was performed using the Cochrane, PRISMA guidelines. The analysis included published studies<sup>3-22</sup> that involved: 1. a control group, and 2. tests studied at least 3 times, by different researchers, or in different pain subgroups. Outcomes were combined within the same cognitive measure, not across measures. Tests were excluded when heterogeneity of variance exceeded  $I^2 = .65$ . Pain subgroups were combined. A research neuropsychologist (WP) supervised cognitive data summarization.

**Results:** 23 studies met criteria and involved heterogeneous pain populations, or subgroups including back pain, whiplash, and fibromyalgia. 21 cognitive subtests had been studied at least 3 times including: subtests from the Wechsler Adult Intelligence Test (WAIS), Test of Everyday Attention (TEA), Corsi Blocks, Paced Auditory Serial Addition test (PASAT), Rey Auditory Learning (RAVLT), Trail Making (TMT), Stroop, and Wisconsin Card Sort (WCST). 19 subtests had sufficient variance homogeneity. Results for Rey Complex Figure immediate and delayed recall subtests were too heterogeneous. There were no group differences on: Corsi Blocks Forward, Digit Span Forward or WCST-Perseverative Errors. Table 2 shows full meta-analysis results.

**Conclusions:** Chronic pain was associated with Effect Sizes of 1/3 to close to a full SD poorer performance. Correlates of chronic pain were non-specific, with relative weaknesses in tests requiring speed, working memory, learning, executive functions, and a range of attention abilities. Consistencies in presence and magnitude of the CP – cognition effect depended on the test, pain subgroup, and study source.

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| Neurocognitive Test                 | Study  | Total Controls (N) | Total Chronic Pain (N) | Overall Standardized Mean Difference (95% CI) | Random p < | Random I2 (%) | Overall Standardized Mean Difference (95% CI) | Fixed p < | Fixed I2 (%) | Interpretation For Effect Size in CP      |
|-------------------------------------|--|--------------------|------------------------|---|------------|---------------|---|-----------|--------------|---|
| Digit Span Forward                  | CaNovas 2009-FM, Kim 2012-FM, Roldan-Tapia 2007-RA   | 87                 | 93                     | -.33 (-.77,.08)                               | n.s.       | 46            | -.31 (-.61, -.02)                             | 0.05      | 46           | Inconclusive Small to moderate            |
| Digit Span Backward                 | Landro 1997-FM, Roldan-Tapia 2007-FM   | 119                | 127                    | -.35 (-.61, -.10)                             | 0.01       | 0             | -.35 (-.68, -.10)                             | 0.01      | 0            | Small to moderate                         |
| Digit Symbol Coding                 | Grace 1999-FM, Lee-UCP 2010, Shur 2003 UCP Schmand 1998-WL, Shur 2003-FM   | 1361               | 376                    | -.36 (-.5, -.22)                              | 0.00001    | 8             | -.34 (-.46, -.22)                             | 0.0001    | 8            | Small to moderate                         |
| Trail Making - A                    | Bosma 2002-WL, DiStefano 1995-6 months-WL, Shur 2003-FM, UCP   | 272                | 285                    | -.32 (-.49, -.15))                            | 0.001      | 0             | -.32 (-.49, -.15)                             | 0.001     | 0            | Small to moderate                         |
| Trail Making - B                    | DiStefano 1995-24 months-WL, Gimse 1997-WL, Weiner 2006-UCP Oosterman 2012-UCP, Schmand 1998-WL, Walitt 2008-FM, UCP | 432                | 448                    | -.38 (-.52, -.25)                             | 0.00001    | 0             | -.38 (-.52, -.25)                             | 0.0001    | 0            | Small to moderate                         |
| PASAT                               | Bosma 2002-WL, DiStefano 1995-6 months-WL, Grace 1999-FM   | 234                | 262                    | -.44 (-.69, -.19)                             | 0.0005     | 43            | -.39 (-.57, -.21)                             | 0.0001    | 43           | Significant Effect Magnitude Inconclusive |
|                                     | DiStefano 1995-24 months-WL, Gimse 1997-WL, Shur 2003-FM, UCP, Sjogren 2005-UCP                                      |                    |                        |   |            |               |   |           |              |   |
| RAVLT- Immediate Recall             | Schmand 1998-WL, Shur 2003-FM, Shur 2003 UCP   | 168                | 186                    | -.52 (-.74, -.31)                             | 0.00001    | 0             | -.52 (-.74, -.31)                             | 0.0001    | 0            | Moderate                                  |
| RAVLT- Delayed Recall               | Kim 2012-FM-immediate & delayed only   | 112                | 133                    | -.57 (-.83, -.31)                             | 0.0001     | 0             | -.57 (-.83, -.31)                             | 0.0001    | 0            | Moderate                                  |
| RAVLT- Recognition                  | Gimse 1997-WL, Grace 1999-FM-immediate only  | 88                 | 110                    | -.51 (-.8, -.23)                              | 0.001      | 0             | -.51 (-.80, -.23)                             | 0.001     | 0            | Moderate                                  |
| Corsi Blocks - Forward              | CaNovas 2009, DiStefano 1995-6 months-WL, DiStefano 1995-24 months-WL, Kim 2012                                      | 81                 | 80                     | -.26 (-.57, .05)                              | n.s.       | 0             | -.26 (-.57, .05)                              | n.s.      | 0            | No Effect                                 |
| RCFT - Immediate Recall             | Bosma 2002-WL, Kim 2012-FM, Lee 2010-UCP   | 1357               | 350                    | -.59 (-1.11, -.07)                            | 0.05       | 82            | -.14 (-.26, .02)                              | 0.05      | 82           | Inconclusive                              |
| RCFT - Delayed Recall               | Roldan-Tapia 2007-FM, RA, Shur 2003-FM, UCP  | 1399               | 395                    | -.38 (-.68, -.09)                             | 0.01       | 58            | -.17 (-.28, -.05)                             | 0.01      | 58           | Inconclusive                              |
| Stroop - word reading speed         | Oosterman 2012-UCP, Schmand 1998-WL  | 132                | 144                    | -.39 (-.64, -.14)                             | 0.01       | 6             | -.39 (-.63, -.15)                             | 0.001     | 6            | Small to moderate                         |
| Stroop - color reading speed        | Walitt 2008-FM, Walitt 2008-UCP  | 132                | 144                    | -.37 (-.61, -.13)                             | 0.01       | 0             | -.37 (-.61, -.13)                             | 0.01      | 0            | Small to moderate                         |
| Stroop - color-word reading speed   |  | 132                | 144                    | -.35 (-.54, -.15)                             | 0.001      | 0             | -.35 (-.59, -.11)                             | 0.01      | 0            | Small to moderate                         |
| Wisconsin Card Sort - Categories    | Shur 2003-FM, Shur 2003-UCP  | 78                 | 81                     | -.24 (-.77, .28)                              | n.s.       | 63            | -.29 (-.60, .03)                              | p = 0.07  | 63           | Inconclusive                              |
| Wisconsin Card Sort - Perseveration | Verdejo-Garcia 2009-FM   | 78                 | 81                     | -0.15 (-.16, 0.47)                            | n.s.       | 0             | -0.15 (-.47, -.16)                            | n.s.      | 0            | No Effect                                 |