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Predictors of Responsivity to Language Intervention: Findings from an RCT

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Background

- Speech and language delays are the most common neurodevelopmental problems of childhood
- Population studies indicate that some 6% of five-year-old children have significant difficulties in language (Law, Boyle, Harris *et al*., 2000)
  - Variability across studies in the stringency of criteria and measures used define language impairment
- Some of these children may have language delay which is *secondary* to conditions such as autism, hearing impairment or more general developmental disabilities
- Others have a *primary delay* which cannot be accounted for in terms of non-verbal ability, hearing impairment, behaviour or emotional problems or neurological impairments Stark & Tallal, 1981; Plante, 1998)

‘Catch-up’…

- Primary speech and language impairment is characterised by high rates of spontaneous remission in the pre-school years (Richman et al., 1982; Silva et al., 1983; Ward, 1992; Rescorla & Schwartz, 1990; Thal & Tobias, 1992)
- Average remission rates of around 50-60% for children aged between 2 and 3 years with expressive language delay (Law et al., 2000)

…and Persistence

- But children with primary impairment can also have long-term difficulties which persist to adolescence and beyond (Stothard et al., 1998; Haynes & Naidoo, 1991)
- Age is thus a particularly strong predictor of progress…
  - If specific language problems resolve by 5½ years then persistent oral language difficulties are less likely, though there may be persistent problems in areas such as spelling and phonological progressing (Stothard et al., 1998)
  - But if the problems persist to 5½ years then subsequent problems in both spoken language and written language, including reading comprehension are highly probable
- Children with difficulties extending across receptive language appear to be at particular risk of persistent problems (Bishop & Edmundson, 1987; Silva et al., 1983; Law et al., 2000) with reduced catch-up rates of only 20-30%

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Underlying Mechanisms

- Wide-spread agreement on multiple risk factors (e.g. genetic factors, socioeconomic status, oral-motor difficulties, though uncertainty regarding chronic otitis media) which may act in a cumulative fashion
- Aetiology of primary language impairment
  - Genetic factors
  - Linguistic Explanations
  - Cognitive Processing Explanations

Genetic Factors

- Twin studies (e.g. Bishop, *et al*., 1995; Bishop *et al.,* 2000; Tomblin & Buckwalter, 1998; SLI Consortium, 2002)
  - Moderate genetic influences evident in the case of expressive language and strong environmental influences are observed in the case of receptive language, particularly in the case of children at the lower end of the distribution (SLI Consortium, 2002; Kovas *et al.,* 2005)

Linguistic Explanations

- Morphosyntax (e.g. syntactical structure & grammatical morphology) (Leonard, 1998; Bortolini *et al.,* 2002)
  - Functional Category Deficits (Loeb & Leonard, 1991)
  - Implicit Grammatical Rule Deficit (Gopnick, 1990)
  - Extended Optional Infinitive Account (Rice & Wexler, 1995; 1996; Rice, 2000)
- Processing inferential meaning (e.g. Bishop & Adams, 1992; Norbury & Bishop, 2002)

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Cognitive Processing Explanations

- **Limited processing capacity** (e.g. Ellis Weismer, 1996, 1997, 2000; Montgomery, 2003)
  - Children with SLI have particular problems in managing the functions of storage and processing where they have to complete two mental operations under time pressure
  - Learning new words or morphemes suffers when processing demands are high (Rice et al., 1994; Ellis Weismer, 1996)
- **Speed of processing** (e.g. Bishop, 1994; Kail, 1994; Lahey & Edwards, 1996; Hayiou-Thomas *et al.,* 2004)
  - Children with receptive/ expressive problems are more likely to have slower RTs across a wide range of verbal and non-verbal tasks than children with expressive problems only and both groups have slower RTs than controls

Cognitive Processing Explanations (cont.)

- **Working Memory**
  - Phonological working memory deficits (e.g. Gathercole & Baddeley, 1990; Montgomery, 2000; Conti-Ramsden *et al.,* 2001)
  - Executive Functions (e.g. Bishop & Norbury, 2005): response inhibition (Booth & Boyle, 2008)
- **Auditory processing deficits**
  - Frequency discrimination (e.g. Tallal, 2000; McArthur & Bishop, 2004; Hill *et al.,* 2005)
  - Rapid auditory processing deficit (e.g. Tallal & Piercy, 1975; Tallal, 1980; Tallal, 1999; McArthur & Bishop, 2004; Hill *et al.,* 2005)
- **Role of Nonverbal Abilities (NVIQ)**
  - Widely-used as an eligibility criterion and for definition of SLI

NVIQ and Language Impairment:

Two Competing Positions:

- "Children with SLI [i.e. with non-verbal functioning within the average range] seem to benefit more from speech therapy, whereas children with cognitive delay seem to benefit more from special education."

  (Goorhuis-Brouwer & Knijf, 2002)

- IQ score does not predict language outcomes (e.g. Cole & Dale, 1986)

Assumption of 'Subtractivity' / 'Residual Normality':

- Impairments in language may be truly independent of other cognitive systems, resulting in SLI
  - Supported by e.g. Ellis & Young (1988); Temple (1997) &Temple & Clahsen (2002)
  - Challenged by e.g.Thomas & Karmiloff-Smith (2002) & Botting (2005)
- *But if truly independent, how useful would measures of NVIQ be in predicting progress in language in response to intervention?*
  - Some evidence from a recent meta analysis that NVIQ might predict responsiveness to intervention in reading comprehension for late primary school pupils (Fuchs & Young, 2006), but position less clear in regard to language impairment

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Predictors of Progress: Evidence from an RCT (Boyle, McCartney, Forbes & O'Hare, 2007; 2008a; 2008b)

- **Design**
  - RCT with a 2 x 2 factorial design (direct/indirect versus individual/group language therapy) together with a control group receiving existing levels of community-based speech and language therapy
  - Participants identified by local speech and language therapy services in Glasgow and surrounding areas and Edinburgh and assessed by members of the project team to ensure that they met the eligibility requirements
  - Pre-intervention baseline assessments (T1)
  - Post-intervention assessments (T2)
  - 12 month follow-up assessments (T3)
  - All post-baseline language assessments carried out by qualified SLTs blind to the children's status and who had no other involvement with the study

Participants

- School-age children (age-range 6;0 – 11;11) with persistent primary receptive and/or expressive language impairment (RE-LI or E-LI)
  - Identified by local community SLTs
  - Primary language impairment (≤-1.25 SD on the CELF-3^{UK} receptive and/or expressive scale, and WASI NVIQ >75) with no reported marked hearing loss, no moderate/severe articulation/phonology/dysfluency problems or otherwise requiring individual SLT work
  - Informed, written parental consent and, where appropriate, written consent from the children themselves
  - 161 participants randomised to one of five conditions...

Summary of Project Intervention

Control Group (N=31)	**Direct Individual** (N=34)	**Direct Group** (N=31)	**Indirect Individual** (N=33)	**Indirect Group** (N=32)
On-going community-based SLT	1:1 sessions delivered by SLT	Small group-based sessions delivered by SLT	1:1 sessions delivered by SLT Assistant	Small group-based sessions delivered by SLT Assistant

Details of Intervention

- Children randomised to a project therapy group received three 30-40 minute sessions per week for 15 weeks in their own school, or in another nearby school, in the case of those in group therapy conditions
- Children in the control group received their ongoing therapy regime from their local SLT service
- SLTAs were trained prior to the intervention phase of the project using an adapted version of the protocols developed by Johnson & Thomas (1995) and the ELKAN training programme
- SLTs reviewed and discussed sessions with the SLTAs, and were responsible for adapting session plans
- There were 101 participants from Glasgow and surrounding areas and 60 from Edinburgh

Intervention (cont.)

- Therapy programmes delivered by the project for each child were based upon initial assessment and followed a therapy manual constructed by the research SLT team (McCartney et al., 2004)
- The therapy manual contained an extensive list of games and activities designed to develop skill in the four language areas of
    - comprehension monitoring
    - vocabulary development
    - spoken grammar
    - spoken narrative
- The manual also provided details of the contexts and relationships that constituted active ingredients of therapy (e.g. encouraging self-reflection and self-monitoring on part of child, practice of targeted language features in a motivating context)
- Mean no. of project therapy sessions delivered over 15 weeks was 38.12 (SD 5.28, range 13 – 45) with high levels of compliance
- Children in the control group received an average of 8.11 contacts with community-based SLT services (SD 13.38, range 0-59)

Assessment Measures

Primary Outcome Measure

- Standardised scores on the CELF-3^{UK} receptive, expressive & composite total scales

Summary of Findings for the 161 participants ('intention to treat') & the 152 participants with T2 post-baseline measures

- T2 language measures (adjusted to take account of T1 scores) revealed no difference in outcome amongst the four research intervention modes (direct & indirect, individual & group) (all p-values > 0.364 & all SES < 0.15) following an average of 22 hours of therapy
  - Benefits to expressive language comparing the four research intervention modes combined with the 'usual therapy' control children ($p<0.05$)
    - But these benefits had 'washed out' by one-year follow-up
  - No significant benefit to receptive language for research intervention children compared with control group children
  - Better outcomes for those with specific expressive language delay than for mixed receptive-expressive ($p<0.025$)
  - Indirect Group mode most cost effective

- Functional benefits ('satisfactory progress') in literacy, numeracy & behaviour also reported by parents at T2 following Direct Therapy

Issues

- Well-trained, well-supported and well-motivated SLAs can effectively deliver of services within primary schools to children with PLI who do not to require the specialist skills of an SLT
- Groups may be as effective as 1:1 (where there are no phonological or articulatory problems)
- Particular problems of children with mixed receptive-expressive problems
- T1-T2 improvements not maintained at T3: need for sustained intervention rather than short-lived ‘package’ approach

- *But what does this tell us about predictors of responsivity to project intervention?*
  - *Odds ratios…*
  - *Role of NVIQ…*

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Logistic Regression Analysis of Predictors of T1-T2 Progress in Response to Project Intervention

- Participants
  - All those who received project therapy with complete post-baseline measures on primary outcome variables (N=124)

- Independent Variables (All binary)
  - CA at T1: < 96 months (N=73) / ≥ 96 months (N=51)
  - Gender: M (N=83) / F (N=41)
  - Type of LI: E-LI (N=23) / RE-LI (N=101)
  - Nonverbal IQ WASI (matrix reasoning and block design): < 85 (N=47) / ≥85 (N=77)

- Dependent Variable
  - Binary outcome variable: ‘progress’ / ‘no progress’

Results

- 63 of the participants (51%) made progress on the CELF-3^{UK} Receptive Language Scale
  - Model for binary gains was statistically significant ($\chi 2$ (df 4) = 20.33, $p < 0.0001$)

- 67 (54%) made progress on the CELF-3^{UK} Expressive Language Scale
  - Model for binary gains failed to achieve statistical reliability ($\chi 2$ (df 4) = 0.942, $p = 0.919$)
  - None of the IVs significantly predicted progress in expressive language as measured by CELF-3^{UK}

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Predictors of Progress T1-T2: Receptive Language

(‘Made Progress’/’Did Not Make Progress’)

	B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% CI*
Receptive Language							
CA at T1 (below/above 8 years)	.747	.402	3.447	1	.063	2.110	.96/4.64
GENDER	.986	.432	5.216	1	.022*	2.681	1.15/6.25
E-LI vs RE-LI	1.660	.581	8.171	1	.004*	5.258	1.68/16.41
NONVERBAL IQ (below/above IQ 85)	-.525	.428	1.506	1	.220	.581	.25/1.37
Constant	-1.906	.595	10.276	1	.001	.149	

Results (cont.) *Receptive Language*

- Model for the Receptive Language Scale accounted for 15.10% (Cox & Snell) and 20.20% (Nagelkerke) of the variance
  - 73% of those who made progress were correctly identified, together with 70.5% of those who did not so progress, for a total success rate of 71.8%
- Children's gender and case status (E-LI/RE-LI) were significant predictors
  - Girls were x 2.68 times more likely to make progress in receptive language than boys (CI 1.15/6.25)
  - Those with RE-LI were x 5.26 times more likely to make progress in their receptive language scores (CI 1.68/16.41)
    - But they had lower T1 scores for receptive language (mean 67.52, SD 4.22) than those with specific expressive language impairment (mean 80.59, SD 8.03): *regression to the mean*?
- No difference in outcomes for NVIQ < 84 or $\underline{\geq}$ 85 (p=0.220, OR=0.591)

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Discussion

- No clear-cut predictors of binary outcome of progress in expressive language
- Gender and pervasive nature of LI were significant predictors of binary outcome of progress in receptive language (though those with RE-LI had more scope for improvement in receptive language than those with E-LI)
  - Note that combined project intervention group did not make significantly greater gains in receptive language than controls
- NVIQ as measured by the WASI did not significantly predict binary outcomes of progress in either receptive language or expressive language
  - Does the test used make a difference?
  - Utility of NVIQ and of the commonly-used SLI criterion of nonverbal IQ 85?
  - Implications for the 'Residual Normality' position?
- Use of more specific measures related to underlying cognitive deficits as well as conventional standardised language tests may help to increase our knowledge of the relationship between underlying theory and intervention outcomes

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