How vocabulary interventions affect young at-risk children's word learning: A Meta-analytic review

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Overview

- Background
- Methods
  - Methodology
  - Analytic plan
- Results
  - Overall analyses
  - Moderator analyses
- Conclusion/Implications
What the research says…

- Oral vocabulary key to transition from oral to written forms (National Reading Panel, 2000)
  - Domain-specific knowledge and later comprehension (Beck & McKeown, 2007)

- Early reading success leads to later reading success and reading motivation (Cunningham & Stanovich, 1997)

- Large SES vocabulary gaps at preschool (Hart & Risley, 1995)
  - 5,000 words at first grade vs. 20,000 (Snow, Burns, & Griffin, 1998)
  - <50% social class effect attributable to <5 yrs (Farkas & Beron, 2004)

- Other risk factors (e.g., ELL, low vocab pretest) affect literacy achievement and learning
  - Stipek et al., 2010; Coyne et al., 2004, 2007 & 2010
  - Matthews et al., 2010 & 2009; McClelland et al., 2006 (SRL)
  - NCES, 2001
These findings led to...

- An influx of educational research focusing on vocabulary interventions for young at-risk children including...
  - Whitehurst, Lonigan et al, 1994; 1998; 1999
  - Hargrave & Senechal, 2000
  - Wasik et al, 2001; 2006
  - Beck & McKeown, 2007
  - Silverman, 2007
  - Coyne et al, 2004; 2007; 2008; 2009; 2010
Meta-Analysis: systematic method for synthesizing & reviewing research

- Marulis & Neuman, 2010: equal gains for at-risk/not at-risk
- Other meta-analyses (e.g., Mol et al., 2008; 2009; Elleman, et al., 2009) focus on general population or broad risk coding
  - Need further information about the effectiveness of training on the improvement of at-risk children’s early receptive and expressive vocabulary (elucidate/address inconsistencies)
  - Types of risk; cumulative risk

- Current meta-analysis: examine vocabulary interventions specifically for variables associated with child outcomes for children with various risk factors.
Methodology

Research questions:

1. To what extent are vocabulary interventions an effective method for at-risk children prior to conventional reading instruction?

2. (How) are various risk populations differentially affected? Is there evidence that vocabulary interventions narrow the achievement gap/accelerate vocabulary development?

3. What factors (e.g., pedagogical, methodological) are associated with significant word learning gains (ES) for children at-risk?

4. How do cumulative risk factors affect children’s vocabulary gains?
Methodology

Eligibility Criteria:

1. Intervention designed to increase word and concept learning (all)
   - Storybook; Taxonomic structure; Symbolic representation (signs); Interactive computer

2. Exp. or quasi-experimental design

3. Children aged 0-6.0, post-test ≤ age 6
   - At-risk ≥ 90% of sample: 1. low-SES; 2. marginalized race; 3. ELL; 4. urban/rural; 5. Language impairments; 6. Low vocabulary score; 7. Low academic achievement
   - Free of developmental or neurological impairments

4. English Word learning DV
   - Expressive (EOWPVT); Receptive (PPVT); author-created & standardized

5. Conducted in English (no pseudo-words)
Methodology

Literature Search:
- Electronic
  - PsycINFO, ISI Web of Science, ERIC, Dissertation Abstract International
- Manual
  - Author correspondence (authors/experts in field)
    - References
    - Published/Unpublished data (address publication bias)

Coding:
- Inclusion
  - Eligibility criteria
  - Fleiss’ kappa = .96
  - k = 67 usable data
- Study Variables
Methodology

Study Variable Coding:

1. **Substantive:** Hypothesis=affect the effect size (ES)
   - Phenomenon of interest
     - At-risk factors

2. **Methods & Procedure:** May affect ES
   - Assignment to condition
   - Nature of control group

3. **Source descriptors:** Not expected to affect ES but will test
   - Study context
     - Country of publication
Methodology

Risk factor coding

(90% criterion)

1. **Low-SES**
   - below the national poverty level of $22,050
   - parent education at high school graduation or below

2. **Marginalized racial group**
   - Parent/experimenter identified

3. **ELL**
   - Teacher/parent reports and how identified

4. **Urban/rural community**
   - Parent/experimenter identified

5. **Language deficits (SLI, IEP)**
   - Parent/teacher and how identified

6. **Low vocabulary score**
   - <85% standard score

7. **Low academic achievement**
   - Title 1, test, teacher reports
Methodology

- **Current Meta-analysis Focus**
  - Birth through age 6; at-risk
  - Preschool and Kindergarten
    - Oral word learning/prior to conventional reading
    - Break down risk factors for nuanced analyses

- 36 papers; 39 studies; 112 ES
Analytic strategy

- Comprehensive Meta-analysis (CMA)
  - M & SD, mean gain scores, $F$ or $t$ statistic
  - Common metric/ES
    - Hedges’ $g = \text{Cohen’s } d \times J (J = 1 – (3 / [4 \times \text{df} – 1] ); \text{df} = N_{\text{TOTAL}} – 2)$
    - Weighted ES by $(1/\text{SE})^2$ effect sizes by the inverse of their error variances.
      - Bias correction (adjusted for sample size)
      - Less precise estimates weighted less in analysis (more conservative)

- Random effects models - overall
  - Variability not limited to sampling error (Heterogeneity)
  - Generalize

- Mixed effects model-moderator analyses
  - Fixed: combine subgroups/examine variance explained by moderators
  - Random: combine studies within subgroups

- Standardized by change SD
Analytic strategy, cont.

- No outliers ($\geq 3 \text{ SD} = .62$)
  - Range: $-.10 - 2.13$

- Publication bias
  - Classic fail-safe N: 5,538 missing studies with null results
  - Exceeds criterion ($5k+10$) 205 where $k=39$ studies, (Rosenthal, 1991)
Results

- Hedges’ $g = 0.94$, SE=0.10, CI$_{95}$= 0.74, 1.14, p<.0001
- 36 papers (14 unpublished); 39 studies; 112 ES
- 2,927 children ($N_{exp} = 1,717; N_{control} = 1,210$)

- .20 small ES
- .50 medium ES
- .80 large ES

(Cohen, 1988)

- .30 bottom quartile
- .50 median
- .67 top quartile

(Lipsey & Wilson, 1993)
Results, cont.

- **Publication**
  - Unpublished (k=14; \(g=0.70\), SE=.11, CI\(_{95}\)=.48, .91)
  - Published (k= 25; \(g=1.07\), SE =.15, CI\(_{95}\)=.77, 1.36)
    \(- Q_b(1)= 3.96, p=.04\)

- **Assignment to condition**
  - Random (k=10; \(g=0.53\), SE=.15, CI\(_{95}\)=.23, .82)
  - Non-random (k=29; \(g=1.07\), SE=.12, CI\(_{95}\)=.84, 1.31)
    \(- Q_b(1)= 8.10, p=.004\)

- **Type of assessment measure**
  - Standardized (k=23; \(g=0.68\), SE=.11, CI\(_{95}\)=.46, .91)
  - Author-created (k=8; \(g=1.37\), SE=.19, CI\(_{95}\)=.98,1.76)
    \(- Q_b(1)= 8.91, p=.003\)

- **Fidelity check**
  - No (k=23; \(g=0.86\), SE=.13, CI\(_{95}\)=.61, 1.11)
  - Yes (k=16; \(g=1.05\), SE=.16, CI\(_{95}\)= .73, 1.36)
    \(- Q_b(1)= .8, p=.37\)
No grade difference

- Kindergarten (k=16; $g=1.13$, SE=.17, CI$_{95}=.80$, 1.46)
- Pre-k (k=23; $g=.80$, SE=.13, CI$_{95}=.56$, 1.05)
- $Q_b(1)=2.46$, $p=.12$

However, meta-regression (method of moments) significant for age

- for every month, increase of .03 in the ES
- $\beta=.03$, SE=.01, CI$_{95}=.008$, .05, Z=2.71, $p=.007$
Planned Moderator Analyses

14 (7 intervention; 7 risk factors)

7 risk factors

- Who benefits most?
  - Risk types (SES, race, ELL, community, SLI, low vocab, low acad. achieve.)
  - Number of factors (cumulative risk; 1-7)

7 intervention

- Who is giving interventions?
- Does group size matter? (1; <5, 6+)
- What length and level of instruction is best? (duration, frequency, intensity)
- Does selecting target words prior to intervention matter?
- What kind of instruction is best? (explicit, implicit, both)
Who benefits most?

- All ages (older children >; no diff. Pk [.80] v. K [1.13])

- **At-risk status** (SES only risk factor significantly related to ES)
  - At-risk groups w/ ≥ 90% low-SES status
    - (k=27; \( g = .80 \), SE=.12 CI\(_{95} \)=.58, 1.03)
  - At-risk groups w/ 50-100% middle to high SES at-risk children
    - (k=9; \( g = 1.50 \), SE=.25, CI\(_{95} \)=1.01, 1.98)
    - \( Q_b(1)=6.32, p=.01 \)

- # risk factors not consistently associated with ES
  - Low-SES studies median 4 factors; M-H SES: 4 factors
  - Median split (4) marginally significant (<median larger ES than >median)
Who is giving interventions?

- Child care providers (k=5; $g=0.23$, SE=.11, CI$_{95}=.02, .44$)
- Parents (k=4; $g=0.71$, SE=.26, CI$_{95}=.21, 1.22$)
- Experimenters (k=10; $g=0.95$, SE=.24, CI$_{95}=.48, 1.42$)
- Certified teachers (k=15; $g=1.25$, SE=.19, CI$_{95}=.89, 1.62$)

- $Q_b(3)=25.91$, $p<.001$
Does group size matter?

- Similar gains for 1:1, ≤5, 6+
- Small groups ≤5 (\(g = .95\), SE = .18, CI\(_{95}\) = .61, 1.30)
- Individual (\(g = .97\), SE = .18, CI\(_{95}\) = .61, 1.33)
- Large groups ≥ 6 (\(g = 1.17\), SE = .35, CI\(_{95}\) = .49, 1.86)
- \(Q_b(2) = .32, p = .85\).
What length / level of instruction is best?

- **Duration** (length in days of instruction)
  - Range: 7-270 days; Median = 56 days of instruction
    - ≤ 56 days: (k=14; \( g = .82 \), SE=.17, CI\(_{95}\)=.48, 1.16)
    - > 56 days: (k=22; \( g = 1.03 \), SE=.14, CI\(_{95}\)=.76, 1.30)
    - \( Q_b(1) = .92, \ p = .34 \)
  - \( \beta = -.001, \ SE = .001, \ CI_{95} = -.003,.002, \ Z = -.55, \ p = .58 \)
What length / level of instruction is best?

- **Frequency** (# total instruction sessions)
  - Range: 3-180 sessions; Median= 30 instruction sessions
  - > 30 sessions: (k=11; \(g=0.94\), SE=.18, CI\(_{95}=.58, 1.30\))
  - ≤ 30 sessions: (k=12; \(g=1.00\), SE=.21, CI\(_{95}=.59, 1.42\))
    - \(Q_b(1)=.05, p=.83\)
    - \(\beta=-.004, SE=.002, CI_{95}=-.01,.001, Z=-1.68, p=.09\)

- **Intensity** (minutes each session)
  - Range: 7-60 minutes; Median= 20 minutes
  - > 20 minutes: (k=11; \(g=1.12\), SE=.21, CI\(_{95}=.70, 1.53\))
  - ≤ 20 minutes: (k=11; \(g=1.16\), SE=.20, CI\(_{95}=.76\))
    - \(Q(1)=.03, p=.87\)
    - \(\beta=-.003, SE=.01, CI_{95}=-.03,.02, Z=-.21, p=.84\)
Does pre-selecting target words matter?

- Words not preselected (k=21; $g=.73$, SE=.12, CI$_{95}$.49, .97)
- Words preselected (k=17; $g=1.22$, SE=.16, CI$_{95}$.90, 1.54)
  - $Q_b(1)= 5.80$, $p=.01$
What kind of instruction is best?

- **Implicit vocabulary instruction**
  - Storybook with incidental exposure (without planned instruction or deliberate word instruction)

- **Explicit/embedded vocabulary instruction**
  - Direct teaching of definitions within meaningful contexts (storybooks or otherwise); multiple extended exposure

- Implicit (k=15; \( g=0.57 \), SE=.13, CI\(_{95}\)=.33, .82)
- Explicit (k=10; \( g=1.01 \), SE=.16, CI\(_{95}\)=.71, 1.32)
- Explicit + Implicit (k=11; \( g=1.52 \), SE=.17, CI\(_{95}\)=1.18, 1.85)

- \( Q_b(2)=20.16, p<.001 \)


![Bar chart showing the comparison of Hedges' g for different types of intervention: Implicit, Explicit, and Combination. The chart indicates significant differences between the groups with stars (*) denoting statistical significance.](image-url)
What kind of instruction is best?

Conclusion

- Largest ES= Coyne, McCoach, & Kapp, 2007, Study 1; $g=2.13$

- Explicit teaching of specific words targeted in advance given by extensively trained experimenters, with 'interactive opportunities...to interact with and discuss target words in varied contexts beyond those offered in the story' (p. 77).

  - Powerful enough to close achievement gap

- Multitier approach Coyne and colleagues
  (e.g., Coyne et al., 2004; 2007; in press; Loftus, 2008; Pullen et al., 2010).

  - Combination of author-created with standardized measures

  - **AC**: sensitivity to detect growth ; **S**: global measure, generative

- Standardized ($g=.68$) may reflect conservative end of vocabulary acquisition in young, at-risk children; growth on author-created ($g=1.37$) on other

  - Moderate to large educational intervention effects
    - Encouraging to IES
1. To what extent are vocabulary interventions an effective method for at-risk children prior to conventional reading instruction?

- Large & educationally significant
  \( (g = 0.94, SE = 0.10, CI_{95} = 0.74, 1.14) \)

- Almost 1 SD improvement
  - Analogous to 15 points on IQ

2. (How) are various risk populations differentially affected? Is there evidence that vocabulary interventions narrow the achievement gap/accelerate vocabulary development?

- Similar gain for risk factors except SES

- Unfortunately, no (though see exemplar studies)
  - “Rich get richer”; start lower, gain less
  - Exacerbate vocabulary differentials
3. What factors (e.g., pedagogical, methodological) are associated with significant word learning gains (ES) for children at-risk?

- Mode of instruction (Explicit/embedded)
- Interveners (experimenters, school teachers, parents)
- Pre-selected target words
- Neither dosage nor group size
- Published, non-random, author-created

3. How do cumulative risk factors affect children’s vocabulary gains?

- Evidence: SES most detrimental rather than cumulative risk

- Area for further investigation
Implications

- Training for child care teachers
- Focus on instructors/instruction over group size, duration
- Targeted interventions for at-risk low-SES
  - Start lower, gain less
  - Some parallel gain / gap remains
    - Explicit instruction by Experimenters/trained teachers & parents
    - Future analyses to determine what matters most for these children
    - Examine highest ES studies (e.g., Coyne et al., 2007)
      - Continual support (embedded/extended; multiple exposure)
      - Planned/goal orientated interventions (pre-select words; instruct w/intention)
- Cognizant of measurement
- More experimental work for causality
  - Systematically manipulate moderator variables
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CMA software- Independent groups
Post test data only using M, SD and n

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CMA software- M, SD and pre-post test Correlation for each group using pre and post test data

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