

Computer-based Reading Intervention with a Phonics Approach for Children with Down Syndrome: Challenges and Achievements

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Overview

- Background
- Aims
- Research questions
- Method
- Results
- Summary



Children with Down Syndrome (DS)

- Specific delays in speech and language development relative to other cognitive domains
- Audio-verbal short-term memory deficits one of the main explanations of their difficulties
- Preference for signing and gestural communication can significantly increase their communicative ability during important developmental periods

Clibbens, 2001

Kent & Vorperian, 2013

Naess et al., 2011

Phonological awareness (PA)

- Ability to attend, identify and manipulate components of speech, e.g. sentences, words, syllables, onset-rimes and phonemes
- Usually develop during pre-school years
- Phonemic awareness assigned a central role as a predictor of individual differences in reading development
- Children with DS do not differ from matched controls regarding letter knowledge
- PA skills contribute significantly to word decoding and reading ability also in children with DS

Lundberg, 2009

Melby-Lervag, Lyster & Hulme, 2012

Lemon & Fuchs, 2010

Graphogame (GG)

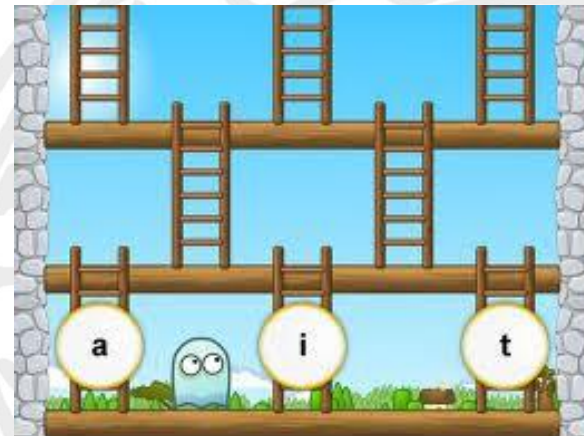
- Innovative digital based learning games, Finland
- Available in different languages
- The Swedish version teaches phonics for beginning readers;
 - **phonemic orthography**

Jyväskylä Longitudinal Study
Lyytinen et al., 2007
Lyytinen et al., 2009



Phonics teaches the child three main things:

- Phoneme-grapheme correspondence
- Blending e.g. c/a/t -> cat
- Segmenting e.g. cat -> c/a/t



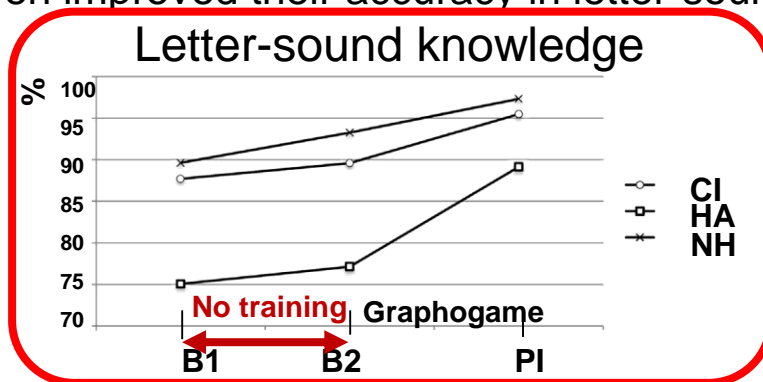
English speaking children improved with GG

- 6-7 year olds with delayed reading
 - Practised 5 times 10-15 min a week over 12 weeks in their educational setting
 - Trained approximately 11 hours
- GG phoneme ($n=10$), GG rime ($n=11$), control group ($n=10$)
 - At 4 month follow-up relative to control group large effect on spelling and small effect on single word reading.
 - Only GG rime had effect on PA tasks

Deaf and hard of hearing improved with GG

Forty-eight Swedish 5-7 year old children practised ≈ 7 min/day at home over 4 weeks (≈ 3 hours)

- Normal hearing ($n=16$)
- Deaf and hard of hearing ($n=32$)
- All children improved their accuracy in letter-sound knowledge



- Children with severe hearing impairment and higher age at implant benefited relatively more on PA from the intervention

- Graphogame focuses on auditory identification of speech sounds and their corresponding letters
- Provides exercises for blending speech sounds into words
- Therefore, the present study was launched to investigate whether also children with DS could benefit from such computer-based phonics intervention

Research questions

- Can children with Down syndrome work independently with Graphogame - a computer- based reading intervention? If not, what kind of adaptation is required?
- Does intensive intervention with Graphogame improve phonological processing and decoding skills in children with Down syndrome?

Participants

- Inclusion criteria
 - Children with DS at school age with interest in letters and reading activities
- 17 participants (11 girls, 5 boys)
 - Nine participants recruited phase 1, Eight children phase 2
 - Mean age 10.0 years (5:8 - 16:9 years)
 - 11 with mild intellectual disability (ID), 6 with severe ID

Method

Test 1

Test 2

Test 3

Group 1	GG training with assistant/teacher (20 school days = 4 weeks)	Regular school activities (20 school days = 4 weeks)
Group 2	Regular school activities (20 school days = 4 weeks)	GG training with assistant/teacher (20 school days = 4 weeks)

Phase I group = 2 interventions Phase II group = 1 intervention



8 weeks

Phase 2 adapted:
Touch screens
Visual time line
15 min GG/session

Teacher log notes and scales

- Teacher log notes regarding child's computer work
 - Attention
 - Progress
 - Independence
 - Need of support
- Visual analogue scale (VAS)
 - Cognitive and communicative skills and interest



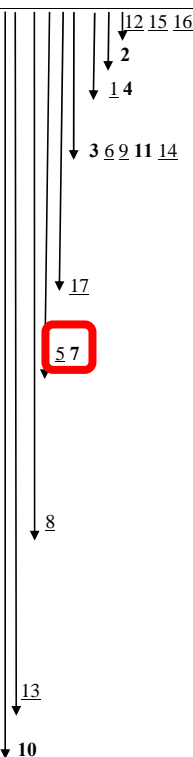
- Letter knowledge
 - Sounds and naming
- Decoding
 - GG words
 - Other real words
 - Nonwords
- PA
 - nonword repetition

Graphogame words GG L1	Real words RW L1	Non-words NW L1
el år ut ja ko ni ny	il ed yl la so rå bu	ak ig ef po vu ry bå
GG L2	RW L2	NW L2
yla hal lås tub ris bok eld	åra sak sil lår mos mur asp	yma påf puv vol ran nif aft
GG L3	RW L3	NW L3
låda myra varm hund gris smaka	lira fota mark häst stor glada	löta fima marf dält tråp vruka

Training data

- Children trained \approx 3:10 h/ intervention
 - One hour difference between children with mild and severe ID ($p = .29$)
 - Phase-I group trained 6:16 h (4:25-7:59 h)
- Reached on average 17 levels
- Did not reach recommended sessions

Two children (5 and 7) who attended two intervention phases and up to 40 intervention sessions were among the highest achievers in the game

Theme	Level	Orthographic content	Participants' level
1	1 - 3	A, O, E, L, S / a, e, o, s, l / a, l, el, os, al	
	4	Word forming 1: al, el, os	
	5 - 9	I, Å, N, R, V / i, å, n, r, v / e, n, en, is, er / å, r, år, le, ås / i, v, ni, vi, lo	
	10	Word forming 2: år, is, en	
	11 - 14	Å, F, P, M, T / å, f, p, m, t / m, f, fe, må, nå / o, t, få, tå, ro	
	15	Word forming 3: ro, må, fe	
	16 - 19	U, B, H, K, J / u, b, h, k, j / ek, el, uv, ur, år / bo, ko, be, ja, ut	
	20	Word forming 4: år, ek, ur	
	21 - 24	Ö, Y, D, G, X / ö, y, d, g, x / då, du, le, på, få / sy, ny, gå, vi, de	
	25	Word forming 5: de, sy, le	
2	26 - 29	Y, U, D, F B / u, y, d, f, b / yr, fe, du, nu, bi / ål, så, te, ta, hö	
	30	Word forming 6: bi, yr, du	
	31 - 34	sal, lås, nos, sol / ros, sår, ris, nål / små, val, mål, får, pil / gås, orm, mäs, arm, nio	
	35	Word forming 7: ris, mäs, sal	
3	36 - 39	duk, yla, fyr, bil, bok, fet / hal, tam, jul, rak, lek, tak / lya, öra, tub, öga, tax, tur / ost, ask, spä, klo, apa, eld	
	40	Word forming 8: yla, lya, öga, yxa, apa	
3	41 - 44	arm, varm, tarm, fest / hund., val, larv, valp, katt / smal, ris, klo, klok, gris / viol, nio, kniv, vink	
	45	Word forming 9: slev, dyna, måne, mura, lera	
	46 - 48	byta, svår, puss, spis, slev / lera, dyna, jama, kula, hota, läda	
	49	Word forming 10: lera, mura, dyna	
	50 - 51	både, möte, jaga, hona, huva, jäsa / saxar, boxas, laxar, saxar, häxa /	
	52	Word forming 11: frukt, svälja, fluga, snigel, vrida	
3	53 - 55	svans, vråla, slug, frysa, fredag, flöjt / slår, snabel, smula, svida, släp, smita, franska, fläta / flyga, skramla, maskerad, vakta, kasta, hosta, snarka starkt	
	56	Word forming 12: sjuk, sjö, sju, vingar, viskning, ängel, promenad	

Teacher VAS scales

- The majority of the children showed average to clear or high interest in communication and taking part in story reading.
- On the group level biggest challenges were observed for use of speech, reading and writing abilities.

Independence

- Nine children needed between 4-10 intervention sessions before they managed the program by themselves without any need of support.
- Remaining half managed the program themselves without any need of support (3 with mild ID) and half needed support throughout whole intervention.
- Behavioral and attentional challenges in the majority of children

Adaptations

- Visual time lines supported attention
- Touch screens helped some
- Pictures and signs helped student's comprehension
- Teacher flexibility and rewards optimal



Intervention effects

- Children training two phases improved their decoding skills of words derived from Graphogame
(pre *Mdn* 2.5 p, post *Mdn* 15.5 p, $p = .05$, $r = .49$)
After 1 phase trends towards significant effects on nonword decoding
(pre *Mdn* 2.0 p, post *Mdn* 12.0 p, $p = .09$)
- Children training one phase improved letter naming
(pre *Mdn* = 20.0 p; post *Mdn* = 23.0 p, $p = .04$, $r = .54$).

However, we did not see that children as a group, after one or two intervention phases, improved more with Graphogame training than with regular school activities.

Independent children

- Independent children's total word decoding scores pre and post Graphogame-training and pre and post regular school activities were analyzed separately (child 6, 8, 10, 17).
- Three of these children improved their total word decoding score after Graphogame training (+13 words) while reduced their total word decoding score (-15 words) post regular school activities

Reading strategies scrutinized

	Alpha T1	Alpha T3	Ortho T1	Ortho T3	Tot T1	Tot T3
Total (raw scores)	45	109	58	71	103	180
% total	43.7	60.6	56.3	39.4		

Proportion of alphabetically decoded words increased after one intervention phase

Two patterns of reading strategy progress

- First, seven children who had little or no decoding skills at the beginning of the study decoded at an alphabetical level after one intervention phase.



e.g. --- → c/a/t

- Second, four children moved from alphabetical reading strategies toward more orthographic decoding strategies at T3

e.g.



e.g. c/a/t → “cat”

And what about PA?

- Nonword repetition did not improve as an effect of intervention
- Children with better speech had better nonword repetition = phase-II group
- Nonword repetition correlated with Graphogame word list 1 (simplest orthographic structures)
- No other correlations were found, ***Did not correlate with age***

Summary

- The majority of children with DS need one-to-one tutoring when taking part in computer-based reading intervention
- Visual time lines and longer intervention periods are optimal
- Children with DS show a huge heterogeneity in reading ability which requires sub-group analyses to enable detection of individual intervention benefits and reading strategies
- Altogether, adaptations with respect to attention, behavioral and fine-motor challenges are warranted to make each child with DS reach their potential in acquiring literacy skills.

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