



## Developing an evidence base for behavioural interventions: A case study of the Headsprout® Early Reading programme

Denne, Louise; Roberts-Tyler, Emily; Grindle, Corinna

### Tizard Learning Disability Review

DOI:

[10.1108/TLDR-12-2023-0036](https://doi.org/10.1108/TLDR-12-2023-0036)

E-pub ahead of print: 14/03/2024

Peer reviewed version

[Cyswllt i'r cyhoeddiad / Link to publication](#)

*Dyfyniad o'r fersiwn a gyhoeddwyd / Citation for published version (APA):*

Denne, L., Roberts-Tyler, E., & Grindle, C. (2024). Developing an evidence base for behavioural interventions: A case study of the Headsprout® Early Reading programme. *Tizard Learning Disability Review*. Advance online publication. <https://doi.org/10.1108/TLDR-12-2023-0036>

#### Hawliau Cyffredinol / General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

#### Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Developing an evidence base for behavioural interventions: Case study of the Headsprout®  
Early Reading programme.

### **Structured Abstract**

**Purpose:** Evidence informed decision making is considered best practice when choosing interventions in applied settings across health, social care, and education. Developing that evidence base, however, is not straightforward. The Sharland Foundation Developmental Disabilities Applied Behavioural Research and Impact Network (SF-DDARIN), a network of like-minded researchers and practitioners from across the UK has implemented a process that systematically develops an evidence base for behaviourally based interventions.

**Design/methodology/approach:** In this case study we describe the progressive research steps undertaken by the SF-DDARIN to develop the evidence base for an on-line reading intervention, the Headsprout® Early Reading programme (HER®) which uses behavioural principles to promote learning to read.

**Findings:** A series of discrete projects targeting gaps in the evidence base for HER® led to the funding of two Randomised Controlled Trials in England, one in Education and one in Health and Social Care.

**Originality:** This case study illustrates an original, creative and effective way of collaborating across academic research departments and applied settings, to systematically extend the evidence base for a chosen intervention.

**Keywords:** Evidence-based practice; evidence continuum; behavioural interventions; reading intervention.

There is a commitment across health, social care, and education in the United Kingdom to the use of “Evidence-based practice”. This is reflected in policy documents such as 'A shared commitment to quality', agreed by national organisations responsible for overseeing quality across the NHS, public health and social care (NHS England, n.d.); National Institute for Health and Care Excellence (NICE) guidelines for putting evidence-based guidance into practice (NICE, 2018); the Welsh Government’s National Strategy for Educational Research and Enquiry (NSERE) (2021), stating that policy and practice should be ‘informed by the best available research evidence’ (p.1); and the Special Education Needs and Disabilities (SEND) code of practice (Department of Health (DoH) and Department for Education (DfE), 2015) which states that education ‘approaches used are based on the best possible evidence’ (p. 25).

But what constitutes “evidence” and how does that translate into best practice? Translational science is concerned with the translation of basic science discoveries into clinical applications that, in turn, are implemented and offer consumer choice (Novins *et al.*, 2013). Translation involves three stages. The first stage is the translation of basic scientific principles established through research into an intervention; stage two expands basic findings to clinical research; and stage three is the widespread adoption of that intervention. Using the science of behaviour analysis to illustrate this, an example is the Picture Exchange Communication System (PECS), an alternative/augmentative communication system developed as an intervention to help people with communication difficulties (Frost and Bondy, 1994). PECS was developed by Lori Frost, a speech pathologist,<sup>1</sup> and Andy Bondy, a behaviour analyst, and uses established behavioural principles (stage one) such as shaping, differential reinforcement, and transfer of stimulus control (Skinner, 1953), along with an understanding of typical language development (Bondy and Frost, 2001) to teach people with

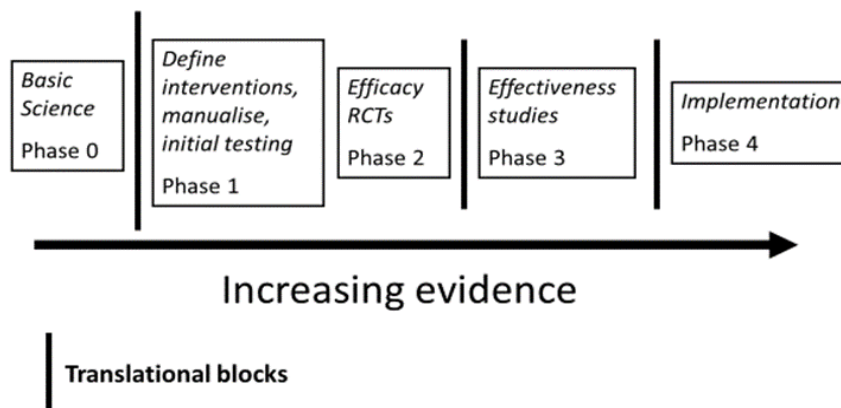
---

<sup>1</sup> The equivalent in the UK is a speech and language therapist

little or no communication abilities to communicate using pictures. PECS was first implemented (stage two) with pre-school autistic students at the Delaware Autism Program (Bondy and Frost, 1994;1998) and there have since been a number of studies (also at stage two) evaluating the effectiveness of PECS in developing functional communication including several systematic reviews and meta-analyses of those studies (Flippin, Reszka and Watson, 2010; Ganz *et al.*, 2012; Preston and Carter, 2009; Sulzer-Azaroff, *et al.*, 2009; Tincani and Devis, 2011). PECS is now a widely used intervention (stage three) internationally and in the UK (May *et al.*, 2023): PECS is a recommended intervention in the Scottish Intercollegiate Guidelines Network (SIGN) 2016 guidelines for autism intervention; and descriptions of PECS are included in many National Health Service websites across England (see <https://justonenorfolk.nhs.uk/media/m4ulmljx/pecs-what-is-pecs.pdf> for an example).

But it is not as simple as that. Thornicroft *et al.*, (2011) (see Figure 1) suggest that stages one and two also involve several necessary phases: 0) basic science discovery; 1) early studies that apply basic science to human problems; 2) early clinical trials; 3) late clinical trials; and 4) implementation. (put Figure1 about here) They also identify what they call translational blocks – points in the process which serve as barriers to moving on to the subsequent phase. They argue that the first translational block, for instance, is the translation of findings from basic science (phase 0) explored in laboratories to the testing of practical applications with humans (phase 1). The second block occurs between phases 2 and 3 which they describe as ‘the interface between efficacy and effectiveness trials, where the former are clinical studies carried out in ideal, experimental conditions, while the latter are those investigations conducted under routine clinical conditions’ (p.2018). The third block is between phases 3 and 3 when interventions move from effectiveness studies into uptake and implementation into real world settings such that they can be delivered accurately and consistently and are effective over time. Within this description is the notion of intervention

fidelity – ‘the degree to which an intervention or programme is delivered as intended’ (p.40, Carroll *et al.*, 2007). Only once phase 4 of the Thornicroft *et al.*, (2011) continuum of evidence is established, can Stage three - the process of widespread adoption of an intervention as identified by Novins *et al.*, (2013), begin.



*Figure 1: A continuum of evidence showing phases of evidence-based practice and potential translational blocks based on Thornicroft *et al.*, (2011)*

Grindle *et al.*, (this issue) outline the process adopted by the Sharland Foundation Developmental Disabilities Applied Behavioural Research and Impact Network (SF-DDARIN) to develop the evidence base for behaviourally based interventions that are delivered in applied settings. A key feature of the SF-DDARIN is that it brings together researchers from academic settings and practitioners from applied settings (including members who work as research practitioners across both settings) to maintain a focus on developing interventions that can be effective in real world practice. There are two principle (but often overlapping) research workstreams: Teaching Skills to Children, Young People and Adults; and Positive Behavioural Support (PBS) across the lifespan. Progressive research

steps such as small scale pilot studies and evaluation of interventions, developing guidelines or a supporting manual for those involved in implementation, feasibility studies and small RCTs are achieved by research collaboration across three tiers of activities: Tier 1, small scale projects that represent phase 1 of the Thornicroft *et al.*, (2011) continuum of evidence often resourced by masters and PhD students; Tier 2, small to medium projects which are a critical step to moving to phase 2; Tier 3, larger scale projects representing phases 2 and 3, including Randomised Control Trials (RCTs).

In this case study we describe the research steps undertaken by the SF-DDARIN to develop the evidence base for the Headsprout® Early Reading programme (HER®), an online programme which uses behavioural principles to promote learning to read.

### **Headsprout® Early Reading programme (HER®)**

HER® makes clever use of behavioural principles established through basic research (phase 0) along with technology to tailor reading instruction to a learner's individual needs. It responds to the learner's performance allowing them to work at their own pace, offers regular practice and repetition opportunities and includes consequences to help correct errors and increase reading fluency. Built in animated sequences keep learners engaged whilst illustrating what they have just learnt.

HER® has been found to be effective with typically developing children (Layng, Stikeleather and Twyman, 2006; Huffstetter *et al.*, 2010; Twyman, Layng and Layng, 2011). Research in the UK with small numbers of children in special schools has suggested that, with the inclusion of some additional support strategies, HER® can also be effective for children with developmental disabilities. Some of the existing research using HER® in the UK had been conducted by network members prior to the setting up of the SF-DDARIN and

this has given the SF-DDARIN a solid platform upon which to build. For example, Grindle *et al.* (2013) investigated the feasibility of using HER® with four autistic children and the adaptations needed to support their progression through the programme. All four children were able to complete the 80 HER® episodes and demonstrated increases in standardised tests of reading that were maintained at eight-week follow-up. Other network members (Tyler, Hughes, Wilson *et al.*, 2015; Roberts-Tyler, Hughes, and Hastings, 2020) also evaluated HER® with students with mild or moderate intellectual disability. In one study, six students aged between 7 and 14 years completed all 80 HER® episodes over 13–21 months, and all made measurable improvements with their reading skills, demonstrating that children with mild to moderate intellectual disability can access (i.e., progress through and benefit from) HER®.

These early phase 1 studies, whilst promising, were not a sufficient evidence base upon which to move research into HER® to phases 2 and 3. Using its tiered approach SF-DDARIN identified a set of further phase 1 studies as well as the necessary phase 2 step of manualising the intervention before moving on to grant applications for larger scale research projects.

### **SF-DDARIN Tier 1 activities (Phase 1).**

SF-DDARIN Tier 1 activities included three master's student projects each of which extended the evidence base across different populations. O Sullivan *et al.*, (2017) used a single subject pre-post-test design to evaluate the feasibility of using HER® to teach basic reading skills to adult offenders with mild intellectual disabilities in a forensic hospital. The rationale for the study centred around the idea that an effective computer-assisted reading programme would represent an opportunity to provide evidence-based and cost-effective reading instruction without needing to seek significant additional educational resources and

funding that might be difficult with an adult population. An additional component to this research design was the inclusion of two “treatment as usual” (TAU) control participants who did not complete the programme. Results were positive in terms of the feasibility of running the programme, and demonstrated improved reading skills, and self-concept scores for both “intervention” participants compared to the “TAU” participants. It is also worth noting that although there were initially concerns that the child-friendly layout of the HER® programme could be viewed by adult participants as childish and patronizing and lead to disengagement, this was not found to be the case. In fact, participants indicated that they enjoyed the cartoon images and general design of the programme and did not make any negative comments at all regarding the presentation of the HER® lessons. This finding had some bearing on the decision to carry out another study with adults, described under Tier 3, below.

Herring *et al.*, (2019) evaluated using HER® over 18 weeks with eight students, aged 7-19 years, who had been diagnosed with a severe intellectual disability, two of whom were non vocal (previous research studies had evaluated using HER® only with students in special schools with mild-moderate intellectual disability). This study was also the first to take place in a school for students with intellectual disability when two notable adaptations to the original HER® intervention were implemented: (a) omission of the speak-out-loud component for the non-vocal students and (b) omission of all negation activities in the online episodes. For the speak-out loud components, a picture of a speaking face would appear on the screen, along with different graphemes/word. Verbal students were required to say out loud the word or sound as they clicked on it. For students who were non vocal, the adult supporting them produced the required oral response at the same time that the student clicked on the graphemes/word (i.e., there was one-to-one correspondence with the adult saying out loud the sound/word as they read it and the student clicking on it). For the negation tasks in HER®, in typical usage of the programme, learners hear a phoneme/word, and are presented



with grapheme(s)/ word, and an arrow on the screen. Learners are instructed to click on the grapheme(s)/word if it matches the spoken phoneme or click on the arrow if it does not. Previous studies had indicated that negation activities are difficult to access for students with intellectual disability (Tyler, Hughes, Wilson *et al.*, 2015; Grindle *et al.*, 2013), possibly because it places a heavy cognitive demand on working memory as it requires learners to hold in mind the aural input whilst comparing it to the written information. For this reason, Herring *et al.* did not require students to complete the negation activities as they were deemed too complex for the chosen population. All verbal students demonstrated increases in scores on standardised reading tests following the intervention. This finding is important since students accessed fewer episodes and received less hours of teaching time than in previous studies. Although the non-vocal students did not show any progress on standardised reading tests, it is worth noting that they did not receive the HER® intervention to fidelity.

Thomas *et al.* (2023) extended this research to evaluate the feasibility of using HER® exclusively with four non-vocal students with a severe intellectual disability who attended a special school in the UK. As well as assessing student outcomes on standardised reading tests after an intervention period of nine weeks, they also investigated teachers' perceptions and experiences of using HER®. In this study additional, table-top activities were designed and implemented which corresponded with the 'speak out loud' exercises of HER®. These were devised to assess whether the students knew the words being spoken. Table-top activities included receptive labelling tasks, blending activities and decoding activities. To give one example, in the receptive labelling activities the students were asked to select, from an array of three cards, a target phoneme (sound) or word that had appeared in a preceding online episode; for example, 'find /ee/', when the cards depicting '/s/', '/ee/' and '/an/' were on the table. This helped to confirm that the student could identify the target sound or word by finding the corresponding card. The results of this study were promising. Three students

improved their early reading skills after just nine weeks of teaching. Staff members also indicated positive experiences of using HER®, especially mentioning how much the students enjoyed the programme and were motivated to engage.

### **SF-DDARIN Tier 2 activities (Phases 1/2)**

The above studies were conducted by trained researchers who were also experts in supporting individuals with an intellectual disability to access HER® i.e., in clinical conditions. A key step in the establishment of an intervention is the development of an implementation manual for any nonexperts likely to be involved in implementation in applied settings. This is particularly the case for HER®. As part of its Tier 2 activities SF-DDARIN members developed a manual to help parents, teaching assistants and support workers support learners using HER® with the focus of the manual on providing additional supports that may sometimes be needed (e.g., suggestions for motivating learners to participate, suggestions for how adults could best support learners when they were completing the online episodes). Recommendations for additional tabletop teaching activities, comparable to those that Thomas *et al.*, 2023 implemented, were also included in the manual to help learners gain confidence in the skills needed to progress through the online episodes. The publication of the manual, funded by SF-DDARIN, was an essential component of a tool kit used to support larger scale studies at Tier 3, (below).

Collaboration through the Teaching Skills workstream also helped to support a single blind pilot RCT (Grindle *et al.*, 2021). University academics from the network helped facilitate the process of advertising for post graduate students from their university, to be offered the opportunity to be trained up, and subsequently to deliver, standardised reading assessments at baseline and post-test to all children in the study. In this study, 55 children from a special school were randomly allocated into an HER® group or a waiting list control group. For six months, children in the intervention group received HER® as supplementary

instruction, whereas children in the control group received only “reading as usual” teaching. Data indicated that the HER® group made improvements at post-intervention in comparison to the control group.

Other examples of Tier 2 projects included the first published study examining the feasibility of using HER® as a parent mediated intervention (Grindle *et al.*, 2019) Prior to this evaluation studies on HER® had only been carried out in school or hospital settings. Grindle *et al.*, were able to train and involve parents of five children with Down Syndrome to support their children’s reading using HER®. After six months, standardised tests of reading ability showed that word reading age improved on average 13 months (range 6 to 20 months).

SF-DDARIN members also conducted an unpublished survey with support workers of adults with intellectual and developmental disabilities, with the purpose of gaining a greater insight into how many adults with intellectual and developmental disabilities have difficulties with reading and the extent to which they may want to learn to read or improve their reading skills. The survey also assessed support worker willingness to help those they support learn to read. Finding out this information was crucial as a prerequisite to carrying out a larger scale study at Tier 3, below.

### **SF-DDARIN Tier 3 activities (Phases 2/3)**

All Tier 2 projects helped to inform the rationale and development of two Tier 3 projects, as described below, and were instrumental in securing successful grant applications for a feasibility RCT and definitive RCT.

Teaching early reading skills to adults with intellectual disabilities (READ-IT) using a support worker/family carer mediated on-line reading programme – a feasibility study was funded (£248k) by the National Institute for Health Research (NIHR) for public benefit fund under their first funding social care call. The aim was to evaluate the feasibility of teaching

adults with learning disabilities to read using HER® mediated by support workers or family carers (Moody *et al.*, 2022). The research proposal directly built upon the Tier 1 O'Sullivan study and the Tier 2 adult reading survey as well as using the HER® support manual funded by the SF-DDARIN. Thirty-six participants were recruited and randomised into an intervention group (19 participants) and a treatment as usual group (17 participants). The key findings will be published shortly (Denne *et al.*, manuscript preparation). In summary the trial found that the trial methods were acceptable; participants and their support workers/family carers were willing to be randomised, 31 participants were retained at follow-up (86.1%), and proposed outcome measures, including health related quality of life data were successfully completed. However, it was not possible to deliver READ-IT with fidelity in the current environment. This was mainly due to staffing changes for support workers (changing rotas and staff absences) and fitting READ-IT into daily activities for participants. It would not be feasible, therefore, to conduct a later definitive RCT of the effectiveness and cost effectiveness of READ-IT without a revised approach.

Headsprout Early Reading in Special Schools (HERiSS Study): A randomised controlled trial was funded by the Education Endowment Foundation (EEF) under its first Special Education Needs and Disabilities funding call. Bangor University was awarded £400,152 to deliver the project, and The University of Warwick £320,485 for its evaluation. The HERiSS proposal directly built upon Tier 1 and Tier 2 studies, in particular the Grindle *et al.*, (2021) small single blind randomised control study, as well as using the HER® support manual. Fifty-five schools and 382 pupils were successfully recruited to the first large scale randomised control trial to be funded in special schools in the UK. The HERiSS protocol and evaluation report are available on the EEF website, and the main outcomes paper is currently in preparation (Flynn *et al.*; manuscript in prep). In summary, children receiving HER® (the intervention group) made no additional progress in reading, on average, in comparison to

children receiving Education as Usual (the control group). However, HER® was not implemented as intended due to various pressures in special schools such as staff turnover and workload, pupil absence, and time constraints. These pressures were exacerbated by the COVID-19 pandemic, which led to the intervention being delayed from September 2020 to September 2021. These difficulties also impacted attrition, which was relatively high in the HER® group as compared with the Education as Usual group. It was therefore difficult to draw firm conclusions about the effectiveness of the intervention.

The results of these two studies, whilst disappointing, illustrate the difficulties identified by Thornicroft *et al.*, (2011) of translating “evidence” established in clinical studies to successful implementation into real world settings. They highlight the need to go backwards in the research continuum to phases 2 and 3 to conduct further research into the facilitators and barriers faced by applied settings in the implementation of HER® and ways to overcome these.

Figure 2 summarises how SF-DDARIN has systematically worked across all three tiers to progressively develop the evidence base for HER® with people with developmental disabilities. (Place Figure two about here).

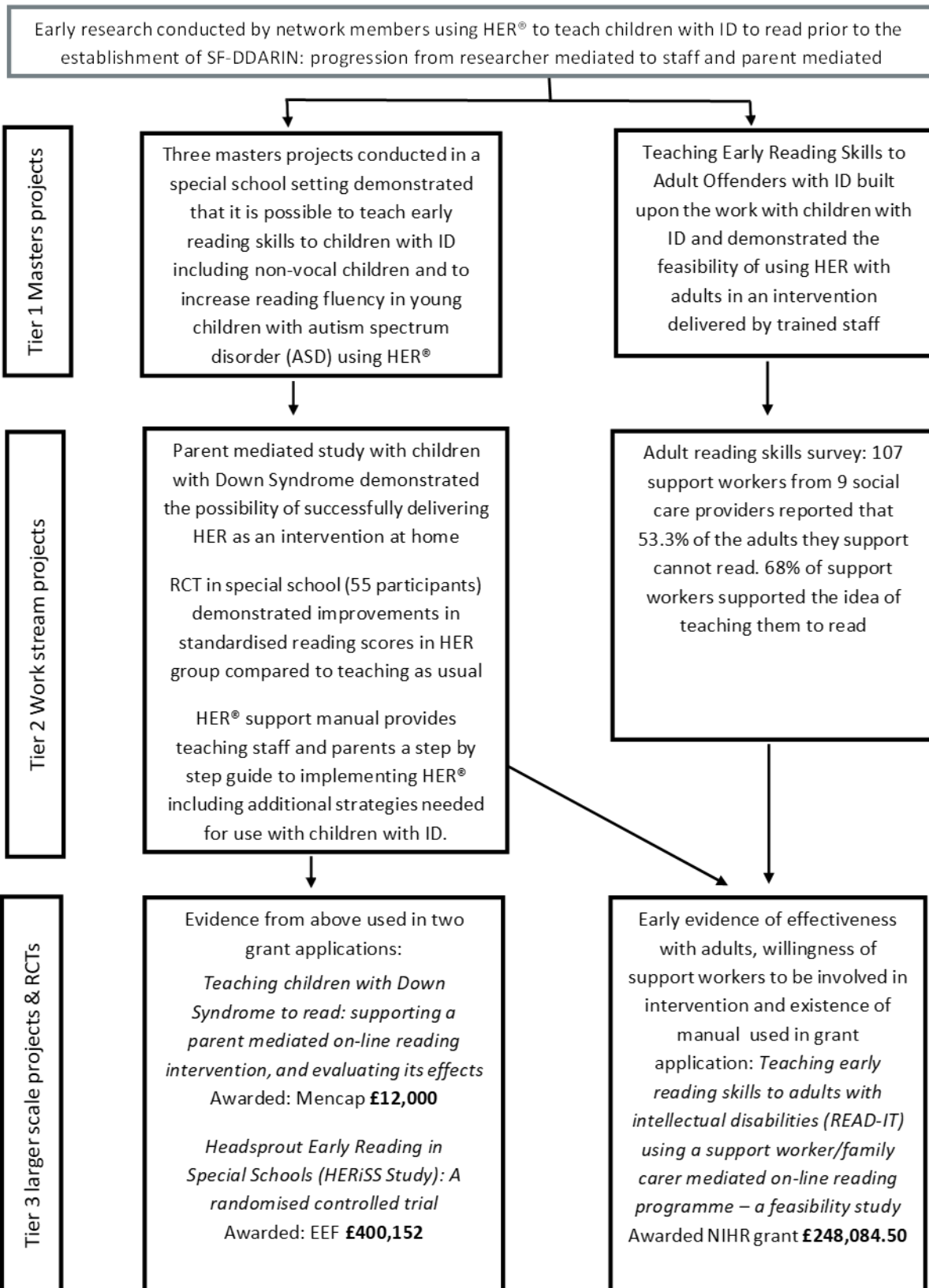


Figure 2: Progressive research steps taken to teach people with developmental disabilities to read using an on-line reading programme, Headsprout®(HER)

## **Conclusion**

The SF-DDARIN's approach to establishing the evidence base for identified interventions is both innovative and resource effective. This is achieved through use of often underutilised sources of research resource in master's and PhD projects as well as outputs in practice settings and through collaboration across both academic and applied settings. By identifying gaps in the evidence continuum, illustrated in this case study by the gaps in the evidence base for HER® as an intervention to teach people with developmental disabilities to read, the SF-DDARIN has been able to successfully move through phases 1 and 2 to research projects in phase 3 and been awarded grants to do so. Whilst the focus of the network is on behavioural interventions the process outlined is potentially relevant to all fields.

## **References**

- Bondy, A. and Frost, L. (2001) 'The Picture Exchange Communication System', *Behavior Modification*, 25(5), pp. 725-744.
- Bondy, A. and Frost, L. (1994) 'The Picture-Exchange Communication System', *Focus on Autistic Behavior*, 9, pp. 1-19.
- Bondy, A. and Frost, L. (1998) 'The Picture Exchange Communication System', *Seminars in Speech and Language*, 19, pp. 373-389.
- Carroll, C., Patterson, M., Wood, S., *et al.* (2007) 'A conceptual framework for implementation fidelity', *Implementation Science*, 2. doi:10.1186/1748-5908-2-40.

Denne, L.D., Moody, G., Coulman, E., *et al.* (manuscript in preparation) Teaching early reading skills to adults with intellectual disabilities using a support worker/family carer mediated on-line reading programme: A Feasibility Randomised Controlled Trial.

Department of Health and Department for Education. (2015). Special educational needs and disability code of practice: 0 to 25 years. [Online] Available at: [www.gov.uk/government/publications/send-code-of-practice-0-to-25](http://www.gov.uk/government/publications/send-code-of-practice-0-to-25) [Accessed 29/11/23].

Education Endowment Foundation (n.d) Headsprout Early Reading in Special Schools (2019 trial) [Online] Available at: <https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/headsprout-early-reading> [Accessed 29/11/23].

Flippin, M., Reszka, S., and Watson, L. R. (2010). 'Effectiveness of the Picture Exchange Communication System (PECS) on communication and speech for children with autism spectrum disorders: A meta-analysis', *American Journal of Speech-Language Pathology*, 19(2), pp. 178–195. doi:10.1044/1058-0360(2010/09-0022).

Flynn, S., Thompson, P.A., Denne, L.D., *et al.* (manuscript in prep) Effectiveness of Headsprout Early Reading® in Special Schools: A cluster randomised controlled trial.

Frost, L. and Bondy, A. (1994) 'The Picture Exchange Communication System Training Manual', Cherry Hill New Jersey, PECS, INC.

Ganz, J. B., Davis, J. L., Lund, E. M., *et al.* (2012). 'Meta-analysis of PECS with individuals with ASD: Investigation of targeted versus non-targeted outcomes, participant characteristics, and implementation phase', *Research in Developmental Disabilities*.



Grindle, C.F., Denne, L.D., Hughes, J.C., *et al.* (this issue) 'Collective effort to enhance the quality of research evidence in intellectual and developmental disabilities: A case study of an academic-practice network'.

Grindle, C.F., Carl Hughes, J., Saville, M., *et al.* (2013) 'Teaching early reading skills to children with autism using MimioSprout Early Reading', *Behavioral Interventions*, 28(3), pp.203-224.

Grindle, C., Tyler, E., Murray, C., Hastings, R.P., *et al.* (2019) 'Parent-mediated online reading intervention for children with Down Syndrome', *Support for Learning*, 34(2), pp.211-230.

Grindle, C.F., Murray, C., Hastings, R.P., *et al.* (2021) 'Headsprout® Early Reading for children with severe intellectual disabilities: a single blind randomised controlled trial', *Journal of Research in Special Educational Needs*, 21(4), pp.334-344.

Herring, E., Grindle, C. and Kovshoff, H. (2019) 'Teaching early reading skills to children with severe intellectual disabilities using Headsprout Early Reading', *Journal of Applied Research in Intellectual Disabilities*, 32(5), pp.1138-1148.

Huffstetter, M., King, J. R., Onwuegbuzie, A. J., *et al.* (2010) 'Effects of a computer-based early reading program on the early reading and oral language skills of at-risk preschool children', *Journal of Education for Students Placed at Risk*, 15(4), pp.279-298.

Layng, T. V., Twyman, J., and Stikeleather, G. (2003) 'Headsprout Early Reading™: Reliably teaching children to read 1', *Behavioral Technology Today*, 3.

May, R. J., Salman, H., O'Neil, S., *et al.* (2023). 'Exploring the use of the Picture Exchange Communication System (PECS) in special education settings', *Journal of Autism and Developmental Disorders*.

Moody, G., Coulman, E., Gillespie, D., *et al.* (2022). 'The READ-IT study protocol for a feasibility randomised controlled trial of using a support worker/family carer mediated online reading programme to teach early reading skills to adults with intellectual disabilities', *Pilot and Feasibility Studies*, 8, 13. doi:10.1186/s40814-022-00972-x.

NHS England (n.d) 'Shared commitment to quality from the National Quality Board'. [Online] Available at: <https://www.england.nhs.uk/wp-content/uploads/2016/12/nqb-shared-commitment-frmwrk.pdf> [Accessed 29/11/23].

NICE (2018) 'Principles for putting evidence-based guidance into practice'. [Online] Available at: <https://www.nice.org.uk/Media/Default/About/what-we-do/Into-practice/Principles-for-putting-evidence-based-guidance-into-practice.pdf> [Accessed 29/11/23].

Novins, D. K., Green, A. E., Legha, R. K., *et al.* (2013) 'Dissemination and implementation of evidence-based practices for child and adolescent mental health: A systematic review', *Journal of the American Academy of Child & Adolescent Psychiatry*, 52, pp. 1009–1025.

O'Sullivan, D.V., Grindle, C.F. and Hughes, J.C. 'Teaching early reading skills to adult offenders with intellectual disability using computer delivered instruction', *Journal of Intellectual Disabilities and Offending Behaviour*, 8, pp. 122-131.

- Preston, D., and Carter, M. (2009). 'A review of the efficacy of the picture exchange communication system intervention', *Journal of Autism and Developmental Disorders*, 39(10), pp. 1471–1486. doi:10.1007/s10803-009-0763-y.
- Roberts-Tyler, E.J., Hughes, J.C. and Hastings, R.P. (2020), 'Evaluating a computer-based reading programme with children with Intellectual Disabilities: feasibility and pilot research', *J Res Spec Educ Needs*, 20, pp. 14-26. doi:10.1111/1471-3802.12458.
- Scottish Intercollegiate Guidelines Network (2016) 'SIGN 145 • Assessment, diagnosis and interventions for autism spectrum disorders. A national clinical guideline'. [Online] Available at: <https://www.sign.ac.uk/assets/sign145.pdf> [Accessed 29/11/23].
- Skinner, B. F. (1953). 'Science and human behavior'. Macmillan.
- Sulzer-Azaroff, B., Hoffman, A. O., Horton, C. B., *et al.* (2009). 'The picture exchange communication system (PECS): What do the data say?', *Focus on Autism and Other Developmental Disabilities*, 24(2), pp. 89–103. doi:10.1177/1088357609332743.
- Thomas, S.E., Grindle, C.F. and Totsika, V. (2023). 'Teaching early reading skills to non-vocal students with severe learning disabilities using Headsprout Early Reading©', *British Journal of Special Education*, 50(1), pp.150-171.
- Thornicroft, G., Lempp, H., and Tansella, M. (2011) 'The place of implementation science in the translational medicine continuum', *Psychol Med* 41 (10), pp. 2015-2021. doi: 10.1017/S0033291711000109.
- Tincani, M., and Devis, K. (2011). 'Quantitative synthesis and component analysis of single-participant studies on the picture exchange communication system', *Remedial and Special Education*, 32(6), pp. 458–470. doi:10.1177/0741932510362494.
- Twyman, J.S., Layng, T.V., and Layng, Z.R. (2011). 'The Likelihood Of Instructionally Beneficial, Trivial, Or Negative Results For Kindergarten And First Grade Learners

Who Complete At Least Half Of Headsprout ® Early Reading', Behavioral Technology Today, 6, pp. 1-19.

Tyler, E.J., Hughes, J.C., Wilson, M.M., *et al.*(2015). 'Teaching early reading skills to children with intellectual and developmental disabilities using computer-delivered instruction: A pilot study', Journal of International Special Needs Education, 18(1), pp.1-11.

Welsh Government (2023). 'The National Strategy for Educational Research and Enquiry (NSERE): vision document'. Available from: <https://www.gov.wales/national-strategy-educational-research-and-enquiry-endorsements-html> [Accessed 8 December 2023]