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Authors	Frizelle, Pauline;McKean, Cristina
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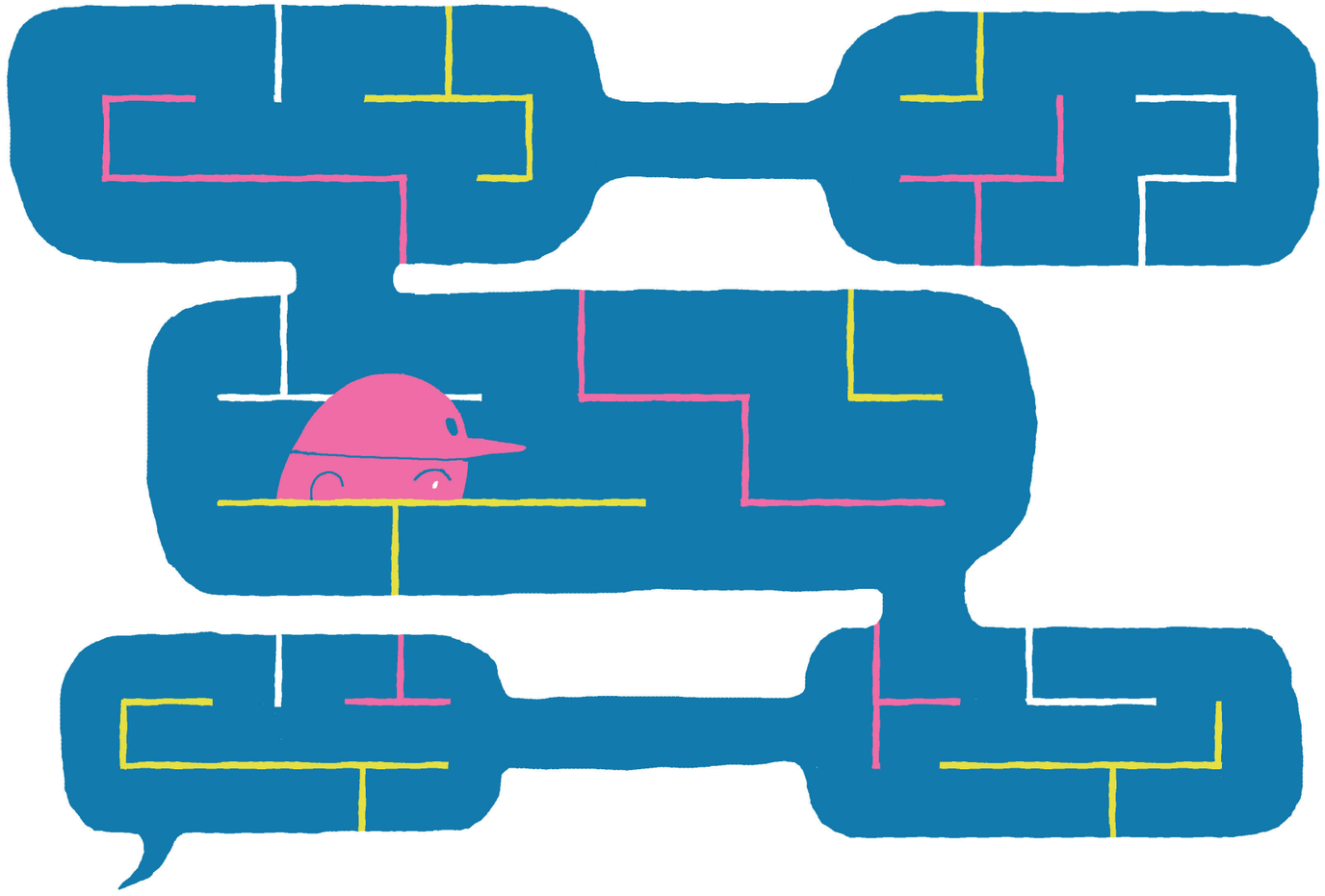
UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh



Active ingredients

Dr Pauline Frizelle *and* **Professor Cristina McKean** *examine dosage effects in interventions for children and young people with developmental language disorder*

ILLUSTRATIONS ADAM McCAULEY



ASK THE EXPERTS

Recent developments in our understanding of the prevalence, nature and consequences of developmental language disorder (DLD) have highlighted the need for the provision of effective speech and language therapy. This growing awareness of the scale of the need has coincided with increasing demand, pressures and fragmentation in children's speech and language therapy services. With such scarce resources and such a large need, it is vital that the intervention we offer is delivered with maximum efficiency, in dosages that can bring about change. The number and quality of speech, language and communication intervention studies with children and young people who have a diagnosis or are at risk of DLD has increased considerably over the last 20 years. This has led to an increased confidence among practitioners and researchers that our interventions can and do effect meaningful change. However, in order for clinicians to be able to use this evidence in practice, there is a need for precision in descriptions of the key components of an intervention that underlie its efficacy: the 'active ingredients'. This would enable clinicians to replicate interventions in a manner that brings about change and, where necessary, to tailor it to an individual's needs while retaining those aspects which are essential for efficacy. Furthermore, it would enable the profession to robustly challenge service provision in dosages with no realistic chance of success.



DR PAULINE FRIZELLE



PROFESSOR CRISTINA MCKEAN

> **Our interventions can and do effect meaningful change**

Dosage: a framework to capture intervention

Traditionally, the concept of dosage has been applied to pharmacological interventions, whereby individuals are prescribed a specific amount of a medication, in a particular form, at a given frequency and over a prescribed period of time (eg 500 mg of paracetamol in tablet form to be taken twice daily, for five days). However, the application of dosage to behavioural interventions is much more complex to describe and, consequently, to measure. In 2007, Warren and colleagues proposed five dosage 'active ingredients' to describe interventions. Four of these refer to aspects of the intervention that can be measured quantitively: dose, dose/session frequency, total intervention duration, and cumulative intervention intensity. The fifth is a qualitative characteristic referred to as 'dose form'. Each of these characteristics is defined as follows.

Dose is "the number of properly administered teaching episodes during a single intervention session". For example, the number of times a child is exposed to or produces a target word or the number of models of a specific structure given to or produced by a child. To increase dose, clinicians can increase the dose within the session (eg by increasing the total number of exposures / productions per session), or overall dose by increasing the number of sessions.

Dose / session frequency refers to the number of intervention sessions per unit of time (ie per day, per week, per month); **total intervention duration** is the total period for which the intervention is provided (eg six weeks); and **cumulative intervention intensity** is the product of the previous three components, ie number of exposures/productions per session x session frequency x total intervention duration.

TABLE 1: Components of dose form and their definitions: qualitative active ingredients

Component	Definition	Examples in practice
Techniques	The specific actions/ teaching behaviours thought to effect change	Providing word definitions (vocabulary), recasting, imitation (morphosyntax)
Procedures	The combination and order of technique delivery	Word exposures followed by word definitions (vocabulary); recasting followed by auditory bombardment (morphosyntax)
Method of instruction	The manner in which techniques are delivered, ie with or without explicit instruction (explicit vs implicit)	Word exposures alone (implicit) versus exposures coupled with detailed explicit definitions of targeted words (vocabulary); recasting (implicit) versus recasting with explicit explanation of the grammatical rule targeted (morphosyntax)
Intervention contexts	This has three subcomponents: 1. The activity within which the technique/ teaching behaviour is being delivered 2. Where the activity sits within a child-centred, clinician-directed continuum 3. The degree of variability/uniformity in the linguistic input or materials used	1. Interactive book reading; play-based activities (both can be adapted for vocabulary or morphosyntax interventions) 2. Choosing vocabulary that relates to the child's interests versus developmentally focused vocabulary; integrating syntactic targets into play-based activities using the child's toys versus drill based target games chosen by the clinician. 3. Target vocabulary presented repeatedly with little linguistic variation (many examples of few words) or with greater variability (few examples of many words); manipulating noun and verb variability within syntactic models or recasts provided by the clinician.

PERMISSION HAS BEEN GRANTED TO REPRODUCE THE ABOVE TABLE ORIGINALLY CITED IN FRIZELLE, P.; MCKEAN, C. USING THEORY TO DRIVE INTERVENTION EFFICACY: THE ROLE OF DOSE FORM IN INTERVENTIONS FOR CHILDREN WITH DLD. CHILDREN 2022,9,859. HTTPS:// DOI.ORG/10.3390/CHILDREN9060859

Therefore, a client who receives 36 word-exposures, given three times weekly for six weeks, would have a cumulative intervention intensity of 648. The same cumulative intensity could also be reached by giving 36 exposures once a week for 18 weeks.

The final qualitative characteristic **dose form** was defined by Warren et al (2007) as "the typical tasks or activities within which the teaching episodes are delivered" and extended by Proctor-Williams to include "the commonly used techniques, procedures, and intervention contexts that constitute teaching episodes". In 2021, we further extended this construct to include other active ingredients that we deemed to be missing from the previous definitions (see Frizelle et al, 2021b). The resulting 'dose form' framework to describe qualitative active ingredients of interventions is shown in the accompanying table (left).

What is known about quantitative active ingredients?

Research demonstrates that each of the active ingredients above impact the effectiveness of interventions for children with DLD. However, because research directly comparing one ingredient to another, or manipulating one qualitative aspect of dosage while controlling for all other variables, is relatively rare (Frizelle et al, 2021a), we cannot be definitive about which are the most impactful or efficient dosage components. However, we can extrapolate key points of learning – particularly in relation to quantitative aspects of dosage for vocabulary and morphosyntax interventions – and we outline these below. The qualitative active ingredients captured by the 'dose form' framework will be addressed in a forthcoming RCSLT webinar.

Perhaps counter-intuitively, studies show that more is not always

KEY LEARNING FOR EFFECTIVE INTERVENTION DELIVERY

Using the quantitative classification system presented in this article should help clinicians track aspects of intervention dosage; in particular, to enable the maintenance of high levels of within-session and ideally overall dose.

Defining what constitutes a dose is key to the successful implementation of interventions. For example, for a given intervention, therapists need to decide if a dose is only when the child is required to do or say something or if the input from the therapist is also a dose.

In relation to cumulative intervention dosage, the literature suggests a minimum requirement for children to achieve their goals. For example, 36 word-exposures per session for 15 sessions for vocabulary intervention for 5- to 6-year-olds with DLD.

Overall dose appears to have greater impact on children's learning than the frequency of the treatment schedule. There is tentative evidence that the same results can be achieved in a shorter timeframe if the within-session dose remains the same and reasonably high (eg 24 recasts in 15 min vs 24 recasts in 30 min).

Weekly or fortnightly sessions are acceptable dose frequency schedules, but only if the dose per session is high. Little and often is also potentially effective, enabling flexibility in scheduling to accommodate parents and or educational practitioners.

More is not always better. Too high a dose can result in diminishing returns, potentially caused by reduced attention, when a target becomes overly familiar. If progress plateaus, we recommend changing intervention targets.

Subtle but simple manipulations of qualitative active ingredients can enhance efficacy, eg:

- varying the referent in vocabulary interventions
- providing auditory bombardment of a target morpho-syntactic structure after recasting
- using explicit teaching at the start of an intervention as children get older (ie 6 to 7 years)
- ensuring all interventions offer children opportunities to produce target forms

There is no magic number for dose or session frequency across language domains. There is sufficient evidence to suggest that SLTs must move away from the practice of delivering a number of pre-determined intervention hours/sessions. Continuing treatment until a child reaches a pre-specified criterion for success aligns more closely with the evidence.

The profession must recognise that removing a child from the classroom or requiring parents to bring children to therapy for interventions that do not provide sufficient dosage to effect change may be unethical.

Service delivery models should be driven by evidence; not by custom and practice.



better. In a vocabulary intervention, Storkel and colleagues (2017) manipulated the number of word-exposures given to 5- to 6-year-old children with DLD. They found that 36 word exposures was optimal but that, following 48 exposures, fewer children responded to treatment. Diminishing returns were also evident in a morphosyntax intervention on past tense production by Meyers-Denman and Plante (2016). The intervention duration ranged from four to 44 days. The longer children received the intervention the less accurately they produced the verbs. The authors' explanation for these findings relates to deficiencies in processing, such that over-familiarity with material leads to decreased attention (Cepeda et al, 2006).

Based on outcomes from composite language measures (such as the CELF-4), Schmitt and colleagues (2016) found that frequent interventions in which language goals are targeted for short periods (two minutes, 2/3 x weekly) or less frequent interventions targeting language goals for longer (20 minutes, 1x per week or fortnight) have yielded the best outcomes.

The spacing or intensity of interventions is also key to service design. One theory of learning posits that it is more efficient if teaching episodes are spaced over several sessions than if they are more densely concentrated into one or a few sessions. Providing a high cumulative dose provides children with numerous opportunities to encode and re-encode new information (Alt and Plante, 2006). On the other hand, spacing between sessions allows children to consolidate their learning in memory (Archibald and Gathercole, 2006), by building on reactivating partially encoded information with each repetition.

Overall, when cumulative dose is controlled, the literature reports no learning advantage for sessions in a spaced rather than concentrated intervention schedule (eg Storkel et al, 2019). Interestingly, this was also found within session, where the spacing of doses was manipulated (24 recasts in 15 min vs 24 recasts in 30 min) but both conditions yielded similar outcomes (Plante et al, 2019). The manipulation of within-session dose is relatively under-researched and larger samples are needed to validate this finding. However, based upon this current best evidence, the 'number of teaching episodes within-session' dose is potentially more important than the session length or spacing of sessions. If this is shown to be consistently the case, it would provide evidence to support significant changes in how speech and language therapy might be delivered.

Clearly, more research is required; however, there is some key learning that can be applied to practice.

DR PAULINE FRIZELLE
p.frizelle@ucc.ie
@pfrizelleslt
PROFESSOR CRISTINA MCKEAN
cristina.mckean@newcastle.ac.uk
@cristina_mckean

REFERENCES
For a full list of references visit: **rcslt.org/references**

Get in touch!

The RCSLT wants to hear from members who used the evidence around dosage to inform their treatment approach.

Please contact **sarah.lambert@rcslt.org** if you would be happy to share your experience.