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**To cite this article:** Zakaria Mestari, Severine Pradel, Aline Veyre & Rachel Sermier Dessemontet (21 Sep 2026): Implementation of the prevent-teach-reinforce model for students with intellectual and developmental disabilities in special schools: a single-case experimental study, International Journal of Developmental Disabilities, DOI: [10.1080/20473869.2026.2730237](https://doi.org/10.1080/20473869.2026.2730237)

**To link to this article:** <https://doi.org/10.1080/20473869.2026.2730237>



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Published online: 21 Sep 2026.



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# Implementation of the prevent-teach-reinforce model for students with intellectual and developmental disabilities in special schools: a single-case experimental study

Zakaria Mestari<sup>a</sup> , Severine Pradel<sup>a</sup>, Aline Veyre<sup>b</sup>  and Rachel Sermier Dessemontet<sup>a</sup> 

<sup>a</sup>University of Teacher Education of State of Vaud, Lausanne, Switzerland; <sup>b</sup>University of Applied Sciences and Arts Western Switzerland, Faculty of Social Work Lausanne, Switzerland

## ABSTRACT

**Background:** Children with intellectual and developmental disabilities (IDD) are at higher risk of exhibiting challenging behaviours (CB). Positive behaviour support interventions like the Prevent–Teach–Reinforce (PTR) school-based model, have demonstrated effectiveness in reducing CB and promoting appropriate behaviours (AB) among students with persistent CB in mainstream schools; however, evidence with students who have extensive support needs in special school settings remains limited.

**Objectives and method:** This single-case experimental study with multiple baselines across participants assessed the effects and social validity of the PTR for four students with IDD in special schools.

**Results:** Implementation was associated with overall reductions in CB and increases in AB, although effects for some students were more apparent during the maintenance phase than during the intervention phase. Variability in behaviour and baseline trends were observed, highlighting the importance of multi-source measurement and ongoing monitoring. Teachers were able to implement PTR intervention plans without prior training and reported high treatment acceptability.

**Conclusion:** Findings suggest that implementing PTR for students with IDD, CB, and extensive support needs in special schools is both feasible and promising. Results highlight the value of structured coaching and attention to contextual factors in intervention planning.

## ARTICLE HISTORY

Received 20 May 2026

Accepted 2 September 2026

## KEYWORDS

Intellectual and developmental disability; positive behaviour support; functional behaviour assessment; Challenging behaviour; teacher-implemented interventions

## Introduction

Children with intellectual and developmental disabilities (IDD) such as autism spectrum disorder (ASD), intellectual disability (ID), or other lifelong conditions that begin early in development and affect social or academic functioning (APA 2022) are more likely to exhibit challenging behaviours (CB) than their neurotypical peers (Simó-Pinatella et al. 2019). These behaviours negatively impact children's quality of life, learning opportunities and social participation, and increase the risk of school exclusion (Lloyd and Kennedy 2014; O'Grady and Ostrosky 2023). The implementation of evidence-based interventions is therefore crucial to mitigate these risks and support long-term educational and social outcomes.

Positive Behaviour Support (PBS) is an evidence-based, multicomponent, multi-tiered framework that promotes person-centred support development through close collaboration with stakeholders to achieve meaningful outcomes in reducing CB (Gore et al. 2013). In their recent systematic review, Begiraj et al. (2022) more specifically describe the multicomponent framework of PBS as: (1) a proactive constructional approach, (2) a non-aversive, socially valid, and person-centred approach, (3) involving the active participation of stakeholders and (4) the use of evidence-based practices. Evidence-based practices to reduce persistent CB among students with IDD involve the use of functional behaviour assessment, and the implementation of a PBS plan aiming at improving the individual's quality of life along with

**CONTACT** Zakaria Mestari  [zakaria.mestari@hepl.ch](mailto:zakaria.mestari@hepl.ch)  University of Teacher Education of State of Vaud, Avenue de Cour 33, Lausanne 1007, Switzerland

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preventing and reducing CB (Goh and Bambara 2012; Walker and Snell 2017). This intervention plan should incorporate preventive strategies, explicit instruction of alternative or appropriate behaviours (AB), and research suggests that involving the students' teachers in the functional behaviour assessment and the team-decision process when planning the PBS plan makes the intervention more effective (Goh and Bambara 2012; Walker and Snell 2017).

The Prevent-Teach-Reinforce (PTR) school-based model is a Tier-3 PBS-based programme that provides a structured and collaborative approach to functional behaviour assessment and intervention planning adapted to address CB in school settings (Dunlap et al. 2019). This programme guides a student's teaching team through five key steps with the support of a trained facilitator: (1) setting goals, (2) data collection, (3) functional behaviour assessment, (4) planning the PBS plan, and (5) assessing intervention plan implementation, effectiveness and decision-making. It also includes a behaviour rating scale and an implementation fidelity checklist, both of which support ongoing data collection and progress monitoring. To date, eight single-case experimental studies (Ayres, Cho Blair, and Kwak 2026; Barnes et al. 2020; Choi and Kim 2018; Deenihan, Cho Blair, and Iovannone 2023; DeJager and Filter 2015; Ford et al. 2024; Strain, Wilson, and Dunlap 2011; Sullivan et al. 2021), and one randomized control trial (Iovannone et al. 2009) support the effectiveness of the PTR school-based model. However, existing research was exclusively conducted within the United-States and primarily focused on mainstream schools, leaving a gap in the literature regarding its effectiveness in special education schools and other educational systems. Moreover, most of the students taking part in the studies were typically developing or had mild disabilities (ASD without ID, learning disabilities, emotional and behavioural disability, language disorder or ADHD). Consequently, the effects of the model on students with IDD with more extensive support needs were not yet sufficiently investigated.

To address this gap, our research team first adapted the PTR school-based model to the context of special schools for students with IDD in the French-speaking regions of Switzerland. In Switzerland, inclusive schooling and special schools exist in parallel, with students with IDD, especially those with more severe limitations in adaptive behaviour and intellectual functioning, typically attending special schools (Müller et al. 2020; Sermier Dessemontet, Bless, and Morin 2012). Special schools

employ special education teachers (holding a master's degree in special education), and social workers in education (i.e. educators), who work collaboratively in low student-to-staff ratio settings. While special education teachers are primarily responsible for instruction and curriculum delivery, social workers in education mainly provide instructional support and assistance that enable students to participate in daily routines and learning activities. In practice, however, qualifications and professional roles are not always clearly distinguished, and many professionals working as special education teachers in special schools do not hold formal qualifications in special education but instead hold a bachelor's degree in social work.

A formal consultation was conducted with four professionals experienced in functional assessments and in planning individualized support for students with IDD and severe challenging behaviour. This consultation ensured that the French translations of the material were culturally appropriate. The experts also recommended several adaptations to optimise its implementation in special schools for students with IDD: (1) collection of information on students' health and communication during the first meeting; (2) a classroom observation by the facilitator before or after the first meeting to obtain a comprehensive view of the student's functioning and environment; (3) conducting the functional behaviour assessment as an interview rather than a questionnaire to allow clarification and guided discussion.

The present study aimed to assess the effectiveness and the social validity of the PTR school-based model, thus adapted, in special schools for students with IDD. Specifically, this study aimed to answer two questions:

1. What are the effects of the PTR implementation on the frequency of challenging and appropriate behaviours among students with IDD in special schools?
2. To what extent do teachers in special schools for students with IDD consider the PTR intervention goals, procedures, and outcomes acceptable?

## Methods

### Setting and participants

#### Recruitment

Recruitment began following approval from the relevant school boards. A document presenting the study was sent to the directors of five special schools for students with IDD, who then distributed it to all their

teachers. Four interested teachers from four different schools contacted the research team. After confirming their interest, they completed a short phone questionnaire to determine their student's eligibility as participants as well as their own. Students were eligible for inclusion if they: (1) exhibited CB at a frequency (at least once a day) or intensity (dangerous or highly disruptive) considered challenging by their teachers, (2) had received a formal diagnosis of intellectual or developmental disability prior to the study, (3) attended the special school on a daily basis, and (4) were not known to have any serious health problems. Teachers were included if they: (1) agreed to actively participate in the full PTR process, and (2) committed to implementing intervention strategies in their classrooms. All four students, along with their respective teachers, met the predetermined eligibility criteria for participation, and consent forms were therefore sent to both teachers and parents of selected students.

Once both teachers, and parents' consent forms were returned, a researcher conducted a classroom observation to ascertain the presence of CB, and pre-intervention questionnaires were completed by teachers. The questionnaire included socio-demographic questions, as well as the Teacher Form (ages 5–21) of the Adaptive Behavior Assessment System, Second Edition (ABAS-II; Oakland and Harrison 2011), a validated tool assessing children's adaptive functioning, with excellent internal consistency (0.98–0.99) and strong test-retest reliability ( $r = 0.90$ ). Concurrently, a member of the research team administered the Leiter International Performance Scale – Revised (Leiter-R; Roid et al. 2013), a standardised non-verbal measure of cognitive functioning particularly well-suited for children with language or communication difficulties. The Leiter-R demonstrates strong psychometric properties, including high internal consistency ( $\alpha = 0.88$  to  $0.96$ ) and robust test-retest reliability ( $r = 0.82$ – $0.91$ ). Both the ABAS-II and the Leiter-R are commonly used to assess the severity of limitations in students with IDD.

### ***Student participants and their teachers***

Alessio was a 5-year-old boy with ASD and a global developmental delay. He was non-verbal and had recently started learning to use an alternative and augmentative communication system (PECS). His CB included biting, prolonged and intense screaming, running and jumping around. He had a non-verbal IQ of 38 on the Leiter-R (Roid et al. 2013), and a global adaptive behaviour score of 41 on the ABAS-II (Oakland and Harrison 2011).

Alessio's teacher was a woman with a master's degree in special education and two and a half years of experience. She worked alongside a social worker in education and an intern. Her class consisted of six students diagnosed with ASD or ID. Classroom strategies implemented for Alessio before the start of the intervention included a highly structured daily schedule and an environment arranged with visual seating cues such as a photo on each student's chair and designated individual workspaces. Individual tasks were designed using a structured format, providing clear visual and spatial organization to support engagement and independence.

Lionel was a 9-year-old boy with ASD. Although verbal, he struggled significantly in communicating functionally with oral language in everyday life. He had an alternative and augmentative communication system (Proloquo on iPad), but he refused to use it at school. His CB included screaming, hitting and kicking others, and throwing objects. He had a non-verbal IQ of 46 on the Leiter-R and a global adaptive behaviour score of 46 on the ABAS-II.

Lionel's teacher was a woman with a master's degree in special education and 10 years of experience. She worked alongside a social worker in education and an intern. Her classroom consisted of eight students with ASD and/or ID. During the initial meeting, she expressed feeling unequipped to manage Lionel's screaming and hitting, triggered almost systematically by requests. When prompted to enter the classroom, he would often throw a tantrum, making it difficult for staff to include him in classroom activities. As a result, Lionel was spending most of the day outside the classroom, either roaming the corridors or playing alone and looking at pictures in a playroom next to the classroom. Classroom strategies implemented for Lionel were largely absent. Teaching staff had ceased insisting on his re-entry into the classroom, as the resulting tantrums were too intense.

Joana was a 13-year-old girl with ASD. She was able to communicate orally with full sentences. However, she initiated no interactions at all with her classmates. Her CB included highly frequent stereotypical behaviours (several per hour) such as rocking, flapping, screaming, and jumping up and down. She had a non-verbal IQ of 79 on the Leiter-R and a global adaptive behaviour score of 51 on the ABAS-II.

Joana's teacher was a woman with a master's degree in special education and 16 years of experience. She worked alongside a social worker in education and an intern. Her classroom consisted of eight students with ASD and/or ID. Classroom strategies

implemented for Joana included visual reminders of expected behaviours, such as staying seated and remaining quiet, displayed on her desk. In addition, staff regularly provided verbal prompts to encourage her to sit and remain calm whenever she began vocalising, jumping, or otherwise disrupting the classroom.

Dorian was an 8-year-old boy with ASD. He struggled in communicating functionally with oral language in everyday life. He used combinations of one to two words to communicate. He had an alternative and augmentative communication system (PECS) but seldom used it in the classroom. His CB included running out of the classroom, disruptive verbal stimulation, and oppositional behaviours. He had a non-verbal IQ of 52 on the Leiter-R and a global adaptive behaviour score of 41 on the ABAS-II.

Dorian was taught by two women, who respectively held a teaching credential in early childhood education and a master's degree in education, with 1 and 5 years of experience. Although they never worked on the same day of the week, they collaborated with the same social worker in education and intern. Their classroom comprised four students with ASD and/or ID. Classroom strategies implemented for Dorian included a structured visual daily schedule for the whole class, along with an individualised schedule for him. He was provided with a clearly designated individual workspace with individual and structured tasks, providing clear visual and spatial organization.

### Research design

A delay multiple-baseline design across participants was employed to assess the functional relation between the implementation of PTR and changes in student behaviour. This design was selected to accommodate the practical constraints of the school setting, allowing participants to enter the study at different times while maintaining experimental control. Importantly, once enrolled, data were collected concurrently across participants, with the intervention introduced in a staggered manner. Baseline durations were staggered across participants and ranged from three weeks with the first participant to six weeks with the last one. Baseline conditions involved business-as-usual practices and were maintained through the fifth meeting, at which point the finalized PBS intervention plan was presented and discussed with the team. The intervention was considered to have formally started at Step 4 of PTR (intervention planning), when the intervention plan was presented and discussed with each team. Intervention phase

durations varied between four and six weeks. Maintenance phase began following the last coaching session with the facilitator and was monitored for a period of three to four weeks. Intervention initiation was sequenced based on clinical considerations, specifically the severity and functional impact of the participants' CB, rather than random assignment.

### Measures

#### Students behaviours

**Individualized behavior rating scale.** The Individualized Behavior Rating Scale Tool (IBRST; Iovannone et al. 2014) was used by teachers to monitor each student's CB and AB identified during Step 1 of PTR. This tool combines teacher judgment with direct observation, using a 5-point Likert-type scale, where 5 reflects high occurrence and 1 reflects low occurrence of the behaviour. Ratings were based on either frequency or duration, depending on each student's behavioural profile. Data were collected daily during a predetermined high-probability academic period, consistent across baseline, intervention, and maintenance phases. The IBRST was developed collaboratively with each team, allowing observation time frames to align with classroom routines and student behaviours, thereby enhancing feasibility and contextual relevance.

**Direct observation grid.** Three graduate students blind to the study's phases were recruited to serve as direct observers of student behaviours in the classrooms. Prior to the observations, they completed a two-hour in-person training conducted by the first author. This training focused on the systematic use of the observation grid, with modeling and guided practice. Additionally, the observers received instructions on how to conduct themselves in class to avoid distracting students and minimise observer bias. Each observer was assigned a primary student to monitor (one observer was assigned two), and they also served as secondary observers for another student to enable inter-observer reliability checks. The observation grid varied for each student, based on the behaviours identified by the team during PTR's first step. It was used to collect data on both CB and AB in terms of frequency, duration, or ratio. Each participant underwent 26 to 28 one-hour observations across all three phases of the study.

#### Inter-observer agreement (IOA)

The IOA was calculated for at least 25% of observation sessions per participant in each phase. For

duration measures, IOA was calculated by dividing the shorter duration by the longer duration and multiplying by 100. For frequency measures, IOA was calculated by dividing the smaller count by the larger count and multiplying by 100. The mean IOA for CB was 81% (range 67% to 100%) for Alessio, 84% (range 72% to 100%) for Lionel, 91% (range 56% to 100%) for Joana, and 90% (range 88% to 100%) for Dorian. The mean IOA for AB was 84% (range 67% to 100%) for Alessio, 97% (range 88% to 100%) for Lionel, 85% (range 50% to 100%) for Joana, and 100% for Dorian.

### **Implementation fidelity of PTR**

The first author conducted one to three classroom observations for each participant during the intervention phase to assess teachers' fidelity of implementation of the PTR intervention plan. Fidelity data were collected using PTR's implementation fidelity checklist, which was tailored to each student's individual intervention plan. The observer recorded whether each step of the intervention plan was implemented correctly. Implementation fidelity was calculated as a percentage by dividing the number of correctly implemented steps by the total number of required steps and multiplying by 100.

Integrity of the process as implemented by the facilitator (first author) was evaluated using a PTR integrity checklist, which assessed whether the researcher followed each step of the process as intended during every meeting. The checklist included 42 items corresponding to the five steps of the PTR process. A PTR expert external to the research team reviewed the documentation produced by the first author and interviewed him about his PTR implementation process using this checklist.

### **Social validity**

At the end of the study, all teachers completed the Treatment Acceptability Rating Form-Revised (TARF-R; Reimers, Wacker, and Cooper 1991). This questionnaire is designed to evaluate how acceptable a clinical treatment or intervention is perceived to be. The scale comprises 20 items: 17 specifically assess the acceptability of the intervention, two assess the perceived severity of the target problem, and one gauges the respondent's understanding of the intervention. Each item is rated on a 5-point scale, with labels varying depending on the item's wording. Responses are coded (or reverse-coded) so that higher total scores reflect greater acceptability.

### **Intervention procedure**

The PTR process was implemented across the five structured steps planned in the programme: (1)

Setting goals, (2) Data collection, (3) Functional behaviour assessment, (4) Intervention planning, and (5) Evaluation and decision-making. These steps were carried out through a series of six to eight team meetings held throughout the study, each lasting approximately 60 min. The first author acted as the facilitator, guiding each team through the process and ensuring consistent implementation. He holds a Ph.D. in psychology, with a background in ABA. Additionally, he has received formal PTR training and has over eight years of experience facilitating its implementation and supervising facilitators working with students with IDD.

#### **Meeting 1 – Step 1 (goal setting)**

All teams completed the PTR's first step (goal setting) during the first week, enabling the development of direct observation grids and prompt baseline data collection. Alessio, Lionel, and Joana's teams each included a teacher and social worker in education, while Dorian's team consisted of two teachers. By the end of the meeting, each team had agreed on the CB to reduce and the AB to promote (see Table 1). The first author then created student-specific observation grids for the trained observers, tailored to the targeted behaviours and using either frequency or duration measures for CB and AB. This meeting lasted about 60 min.

#### **Meeting 2 – Step 2 (data collection)**

Alessio's team, which was selected to start first, completed the second step during the same meeting as the first one. Lionel, Joana and Dorian respectively completed this step on week 2, 3 and 4 of the trial. During this second meeting, the IBRST was developed collaboratively with each team, reviewed in detail, and the teaching teams were trained by the facilitator on how to use it. This meeting lasted about 60 min.

#### **Meeting 3 – Step 3 (functional behaviour assessment)**

This meeting took place one week after the previous one for all teams. During the session, the IBRST was reviewed to ensure that all participants fully understood how to use it consistently. The team then engaged in the functional behaviour assessment, using PTR's assessment checklist as a guide for interviews. Before the next meeting, the facilitator integrated the results to develop a draft hypothesis statement. This meeting lasted about 60 min.

**Table 1.** Students' behaviours, definition, observation Window and IBRST range.

|         | Type | Behaviour             | Operational definition                                                                                                                                                                                                                                                                                                    | Observation                                          | IBRST Range                               |
|---------|------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-------------------------------------------|
| Alessio | CB   | Screaming             | He emits loud, high-pitched, and piercing screams repeatedly. Do not count repeated vocalisations related to self-stimulation (e.g. screams of joy, humming, nursery rhymes, etc.). To consider two screams as distinct occurrences, they must be separated by at least one minute.                                       | Mornings from arrival to lunch (3h)                  | 5 = 11 times or more<br>1 = Never or Once |
|         | CA   | React to his name     | When an adult calls him by name loudly enough for him to hear, he responds in one of the following ways: turns his body or head towards the person, moves towards them, or makes eye contact.                                                                                                                             | Mornings from arrival to lunch (3h)                  | 5 = 11 times or more<br>1 = Never or once |
| Lionel  | CB   | Screaming             | He emits loud, high-pitched, and piercing screams repeatedly. Do not count repeated vocalisations related to self-stimulation (e.g. screams of joy, humming, nursery rhymes, etc.). To consider two screams as distinct occurrences, they must be separated by at least one minute.                                       | All School Day from arrival to departure (7h)        | 5 = 10 times or more<br>1 = Never         |
|         | CA   | Make demands          | He makes a verbal and calm request, without any signs of self-stimulation immediately before or during the request (flapping, high-pitched sounds). The requests must include: the adult's name and at least two words (e.g. "Name, want book").                                                                          | All School Day from arrival to departure (7h)        | 5 = 4 times or more<br>1 = Never          |
| Joana   | CB   | Stereotypic behaviour | She displays physical and verbal agitation. Physical agitation is characterized by jumping up when standing or bouncing on her chair when seated. Verbal agitation is manifested by shouting, repetition of words, phrases, or questions. (Note whether it is motor agitation, verbal agitation, or both simultaneously). | During morning learning activity (30 min)            | 5 = 7 times or more<br>1 = Never or once  |
|         | CA   | Interact with peers   | She exhibits one of the following behaviours: approaching others, calling them by their name, asking them for something, speaking to them, or asking them a question.                                                                                                                                                     | During morning free time (30 min)                    | 5 = Spontaneously<br>1 = Never            |
| Dorian  | CB   | Opposition            | Following a request or during a task, he exhibits a refusal to cooperate and passively resists. A request is defined as: a first request, followed by a 5-s wait; a repetition of the request, followed by another 5-s wait.                                                                                              | During morning learning activity and snack time (1h) | 5 = More than 80%<br>1 = Less than 20%    |
|         | CA   | Make demands          | He makes a verbal request that includes a pronoun, a verb, and the object, action, location, or person involved (e.g. "I want pencil"). Repeated responses following the adult's model are also accepted.                                                                                                                 | During morning learning activity and snack time (1h) | 5 = 8 times or more<br>1 = Never or once  |

Note: CB = Challenging Behaviour, AB = Appropriate Behaviour, IBRST = Individualized Behavior Rating Scale Tool.

#### **Meeting 4 – Step 4 (intervention planning – choosing intervention strategies)**

This meeting occurred one week later for Alessio's and Lionel's teams and two weeks later for Joana's and Dorian's teams. Teams reviewed and reached consensus on the draft hypothesis statement (see Table 2) and then discussed together to select interventions from the PTR menu across Prevent, Teach, and Reinforce categories they would implement. Together with the facilitator they then detailed each intervention (see Table 2). This meeting lasted about 90 min.

#### **Meeting 5 – Step 4 (intervention planning – PBS intervention plan)**

This meeting took place one week after the previous one for all teams. During the session, the PBS intervention plan (previously developed collaboratively with the team and guided by the facilitator) was presented and further detailed. More complex strategies

were explained, each step modelled and role-played with performance feedback. The team was then expected to start implementing the programme until next meeting. This meeting lasted about 90 min.

#### **Meetings 6 to 8 – Step 5 (Evaluation and decision-making)**

Three coaching meetings were held after the intervention began, during which the facilitator supported teams in implementing the PBS plan and monitored fidelity using PTR's fidelity checklist. Classroom practices were observed by the facilitator prior to providing feedback, which consistently began and ended with positive comments while encouraging self-reflection on challenges and potential solutions. When adjustments or modifications to the strategies were needed, collaborative discussions were held to ensure that all team members understood and agreed upon revised strategies. Teams also reviewed student

**Table 2.** Students' functional behavioural hypotheses and support strategies.

|         | Functional Behavioural Hypotheses                                                                                                                                                                                                                                                                                                                                   | Strategies                                                                                                                                                                                                           |                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                        |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |                                                                                                                                                                                                                                                                                                                                                                     | Prevent                                                                                                                                                                                                              | Teach                                                                                                                                                                                                                   | Reinforce                                                                                                                                                                                                                                                              |
| Alessio | When a preferred activity ends, a non-preferred activity begins, or access to a desired item or activity is denied, the student engages in screaming. This behaviour appears to function to escape or delay non-preferred demands, terminate transitions, or gain access to preferred outcomes <i>via</i> adult mediation.                                          | <ul style="list-style-type: none"> <li>• Transition support (visual and adult guidance)</li> <li>• Antecedent modification (hiding lunchbox)</li> </ul>                                                              | <ul style="list-style-type: none"> <li>• Teach communication skills (pointing and pictograms)</li> <li>• Teach social skills (react to his name)</li> <li>• Teach coping strategies (asking for a calm spot)</li> </ul> | <ul style="list-style-type: none"> <li>• Reinforce PECS use and asking for a calm spot</li> <li>• Reinforce response to name</li> <li>• Withhold reinforcement for screaming (maintain demands or ignore) and redirection to PECS</li> </ul>                           |
| Lionel  | When a preferred activity ends, a preferred object is removed, or the student is asked to enter the classroom or complete a task, he engages in screaming. This behaviour appears to serve multiple functions: to avoid or delay non-preferred tasks, to terminate ongoing demands, and to continue engaging in preferred activities despite adult prompts to stop. | <ul style="list-style-type: none"> <li>• Environmental support (visual schedule, adapted seatwork place in the class)</li> <li>• Offer choices (activities and reinforcers)</li> <li>• Peer collaboration</li> </ul> | <ul style="list-style-type: none"> <li>• Teach communication skills (short but clear three words sentences)</li> <li>• Teach coping strategies (say "no", ask for a break or to be left alone)</li> </ul>               | <ul style="list-style-type: none"> <li>• Reinforce appropriate requests and classroom participation</li> <li>• Reinforce say "no" or asking for a break</li> <li>• Discontinue CB reinforcement (maintain demands) and redirection to "no" or ask for break</li> </ul> |
| Joana   | Before and during transitions, when structure is unclear, the classroom is noisy, peers are moving around, or unexpected events occur, the student engages in self-stimulatory behaviours. This behaviour appears to serve dual functions: to support sensory self-regulation and to access adult attention and assistance.                                         | <ul style="list-style-type: none"> <li>• Transition support (visual schedule)</li> <li>• Environmental accommodation (minimise visual stimulation)</li> <li>• Peer collaboration</li> </ul>                          | <ul style="list-style-type: none"> <li>• Teach coping strategies (ask to get out of the classroom to auto-stimulate)</li> <li>• Teach social skills (ask questions to peers)</li> </ul>                                 | <ul style="list-style-type: none"> <li>• Reinforce appropriate requests (to go out and to peers)</li> <li>• Respond consistently to stereotyped behaviours with minimum attention and redirecting to asking to go out of the classroom</li> </ul>                      |
| Dorian  | During learning tasks, when given instructions, or during transitions to non-preferred activities, the student engages in passive non-compliance. This behaviour appears to function to avoid or delay the start of disliked tasks and to resist demands to end preferred activities.                                                                               | <ul style="list-style-type: none"> <li>• Offer choices (activities order and reinforcers)</li> <li>• Adjust the teaching programme (shorter and easier tasks)</li> </ul>                                             | <ul style="list-style-type: none"> <li>• Teach communication skills (short sentences)</li> <li>• Promote independent and spontaneous participation</li> </ul>                                                           | <ul style="list-style-type: none"> <li>• Reinforce appropriately worded requests and active participation</li> <li>• Withhold reinforcement for opposition by maintaining demands</li> </ul>                                                                           |

progress to make data-based decisions. These coaching meetings lasted between 45 and 90 min.

## Analysis

To evaluate the effects of PTR, data were analysed through a combination of visual inspection, non-parametric effect size estimation, and descriptive statistics. Analyses were carried out in R Studio (v. 2024.12.1) using the *scplot* package and the *scan* package. For each participant, CB and AB were plotted across three distinct phases: baseline, intervention, and maintenance. Data originated from two sources: the direct observation grid and teachers' IBRST ratings. To complement visual analysis, Tau-BC effect sizes were calculated. Tau-BC is a non-parametric metric that measures the degree of non-overlap between baseline and intervention data, adjusting for baseline trend when significant. It was interpreted as follows:  $< 0.20$  = 'small',  $0.20-0.60$  = 'moderate',  $0.60-0.80$  = 'large', and  $> 0.80$  = 'very large' (Vannest and Ninci 2015).

## Results

### Challenging behaviours

Figure 1 and Figure 2 display all participants' IBRST and direct observation ratings for CB across baseline, intervention, and maintenance phases. Table 3 presents effect sizes for CB and AB.

#### Alessio

During baseline, Alessio's CB, as rated on the IBRST, showed a decreasing trend, warranting trend correction in subsequent analyses. His mean score decreased from  $M=2.93$  (range = 1–5) during baseline to  $M=2.13$  (range = 1–4) during the intervention phase, reflecting a small and non-significant effect ( $\tau = -0.20$ ,  $p = 0.150$ ). In the maintenance phase, the mean further decreased to  $M=1.83$  (range = 1–3), although this change remained statistically non-significant ( $\tau = -0.21$ ,  $p = 0.190$ ). Despite the absence of significant effects, reductions in both mean level and variability across phases suggest a gradual decrease in the frequency and variability of Alessio's CB.

Direct observation data indicated that during the baseline phase, Alessio's CB occurred for a mean

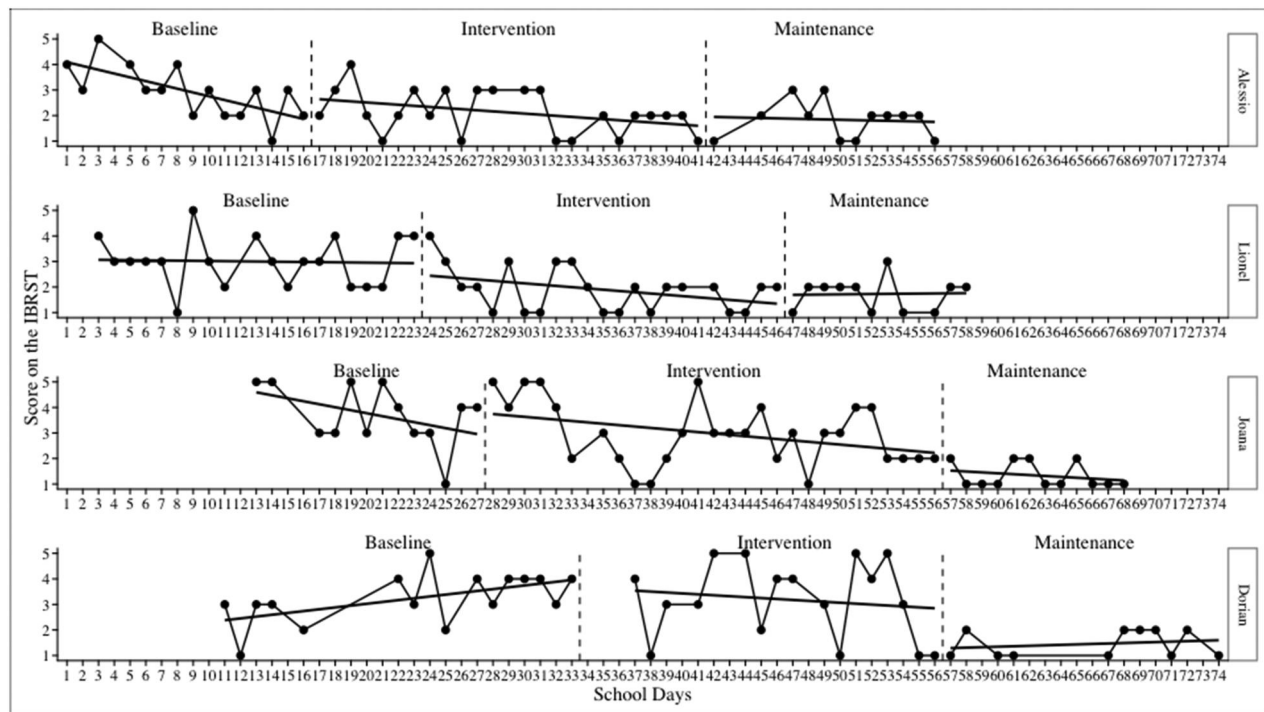


Figure 1. Teachers' daily monitoring of challenging behaviours using the IBRST.

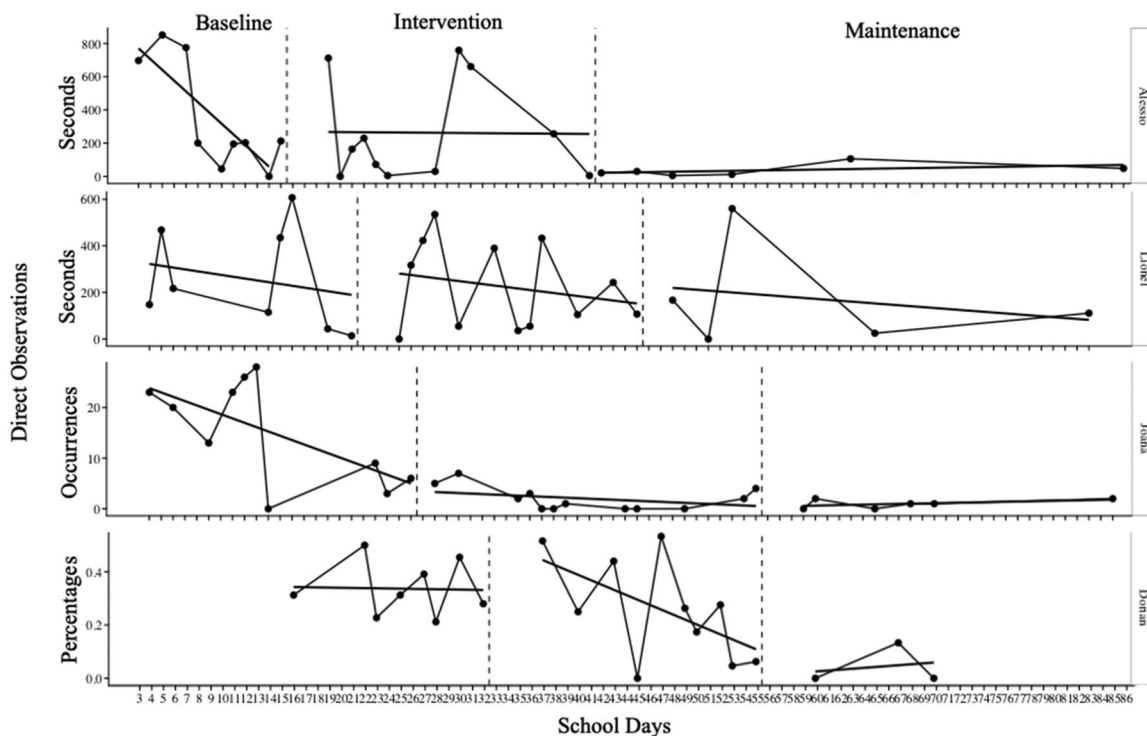


Figure 2. Direct observation of challenging behaviours.

duration of 353 s (range = 0–851). During the intervention phase, this mean decreased to 263 s (range = 0–759) and further declined to 37 s (range = 5–106)

during maintenance. Although the comparison between baseline and intervention was not statistically significant, a large effect was observed when comparing baseline to

**Table 3.** Effect sizes (Tau-BC) for challenging behaviours and appropriate behaviours.

|                      | Challenging behaviour   |                    |                        |                    | Appropriate behaviour   |                    |                        |                    |
|----------------------|-------------------------|--------------------|------------------------|--------------------|-------------------------|--------------------|------------------------|--------------------|
|                      | Baseline – Intervention |                    | Baseline – Maintenance |                    | Baseline – Intervention |                    | Baseline – Maintenance |                    |
|                      | IBRST (Teacher rating)  | Direct observation | IBRST (teacher rating) | Direct observation | IBRST (teacher rating)  | Direct observation | IBRST (teacher rating) | Direct observation |
| Alessio <sup>a</sup> | –0.20                   | –0.20              | –0.21                  | –0.70*             | 0.67*                   | 0.68*              | 0.91*                  | 0.79*              |
| Lionel <sup>b</sup>  | –0.65*                  | –0.15              | –0.77*                 | –0.30              | 0.47*                   | 0.77*              | 0.34*                  | 1.00*              |
| Joana                | –0.39                   | –0.79*             | –0.92*                 | –0.85*             | 0.69*                   | –0.12              | 1.00*                  | –0.07              |
| Dorian               | 0.02                    | –0.30              | –0.89*                 | –1.00*             | 0.37                    | 0.69*              | 0.85*                  | 0.53               |

Note: IBRST = Individualized Behavior Rating Scale Tool.

<sup>a</sup>Alessio's CB values were calculated using baseline trend corrections due to significant trend autocorrelation ( $\tau = 0.55$ ,  $z = -2.66$ ,  $p < 0.01$ ).

<sup>b</sup>Lionel's AB values were calculated using baseline trend corrections due to significant trend autocorrelation ( $\tau = 0.42$ ,  $z = -2.42$ ,  $p < 0.05$ ).

\* $p < .05$ .

maintenance ( $\tau = -0.70$ ,  $p < 0.001$ ), suggesting a marked reduction in CB over time.

### Lionel

During baseline, Lionel's CB, as rated on the IBRST, showed a stable trend ( $b = -0.01$ ). His mean score decreased from  $M = 3.00$  (range = 1–5) during baseline, to  $M = 1.91$  (range = 1–4) during the intervention phase, corresponding to a large and statistically significant effect ( $\tau = -0.65$ ,  $p < 0.001$ ). In the maintenance phase, the mean further decreased to  $M = 1.73$  (range = 1–3), with an even stronger effect compared with baseline ( $\tau = -0.77$ ,  $p < 0.001$ ). Visual inspection of the data supports these results, showing a marked and sustained reduction in CB frequency and variability across phases, with stable lower levels during maintenance.

Direct observation data indicated that during the baseline phase, Lionel's CB occurred for a mean duration of 256 s (range = 14–607). This mean decreased slightly to 225 s (range = 0–535) during intervention and to 173 s (range = 0–560) in the maintenance phase. Statistical comparisons between phases were non-significant, but the visual analysis indicated a downward trend in both level and variability, suggesting partial maintenance of intervention effects.

### Joana

During baseline, Joana's CB, as rated on the IBRST, showed a decreasing trend. Her mean score decreased from  $M = 3.69$  (range = 1–5) during baseline to  $M = 2.96$  (range = 1–5) during the intervention phase, reflecting a moderate but marginally significant effect ( $\tau = -0.39$ ,  $p = 0.070$ ). In the maintenance phase, the mean further decreased to  $M = 1.33$  (range = 1–2), corresponding to a very large and statistically significant effect compared with baseline ( $\tau = -0.92$ ,  $p < 0.001$ ). Visual analysis indicated a sustained reduction in CB variability following the introduction of the intervention, with very low variability and

frequency during maintenance, suggesting strong maintenance of the programme's effects.

Direct observation data indicated that during the baseline phase, Joana's CB occurred for a mean of 15 occurrences (range = 0–28). This decreased sharply to  $M = 2$  (range = 0–7) during the intervention phase and to  $M = 1$  (range = 0–2) in the maintenance phase. Statistical analyses revealed a large effect for the intervention phase ( $\tau = -0.79$ ,  $p < 0.001$ ), and a very large effects for the maintenance ( $\tau = -0.85$ ,  $p < 0.050$ ). Consistent with visual inspection, these results indicate a substantial and lasting reduction in Joana's CB following the implementation of the intervention.

### Dorian

During baseline, Dorian's CB, as rated on the IBRST, showed a slight increasing trend. His mean score stayed roughly the same from  $M = 3.25$  (range = 1–5) during baseline to  $M = 3.18$  (range = 1–5) during intervention, corresponding to no significant effect. In contrast, during the maintenance phase, his mean score decreased to  $M = 1.46$  (range = 1–2), representing a very large effect compared with baseline ( $\tau = -0.89$ ,  $p < 0.001$ ). Visual inspection of the data revealed high variability during baseline and intervention, followed by an abrupt and stable decrease in CB during maintenance, suggesting that treatment effects may have emerged and consolidated over time rather than immediately after intervention took place.

Direct observation data indicated that during the baseline phase, Dorian's CB occurred at a mean ratio of 34% (range = 21%–50%). This decreased slightly to  $M = 26\%$  (range = 0%–53%) during the intervention phase and further declined to  $M = 4\%$  (range = 0%–13%) during maintenance. Statistical comparisons indicated no significant change between baseline and intervention, but a very large effect between baseline and maintenance ( $\tau = -1.00$ ,  $p < 0.05$ ). Visual analysis confirmed this trend, showing a delayed yet pronounced decrease in CB frequency and variability during the final phase.

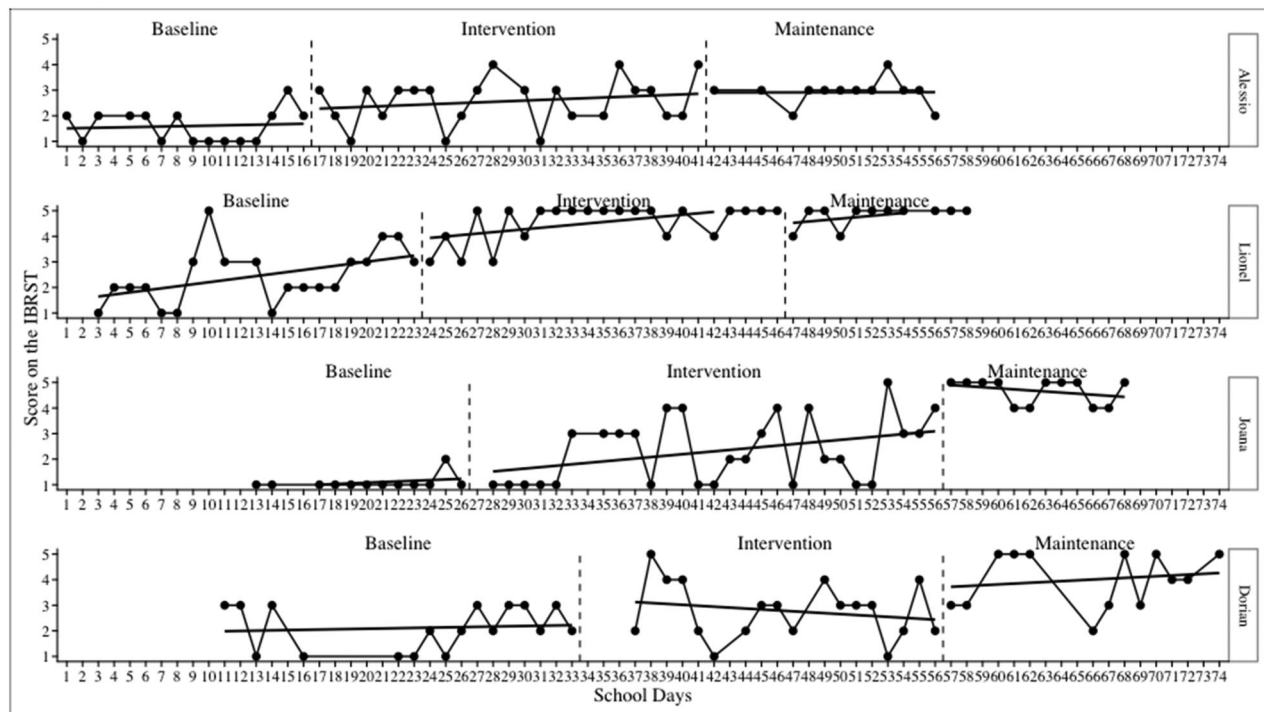


Figure 3. Teachers' daily monitoring of appropriate behaviours using the IBRST.

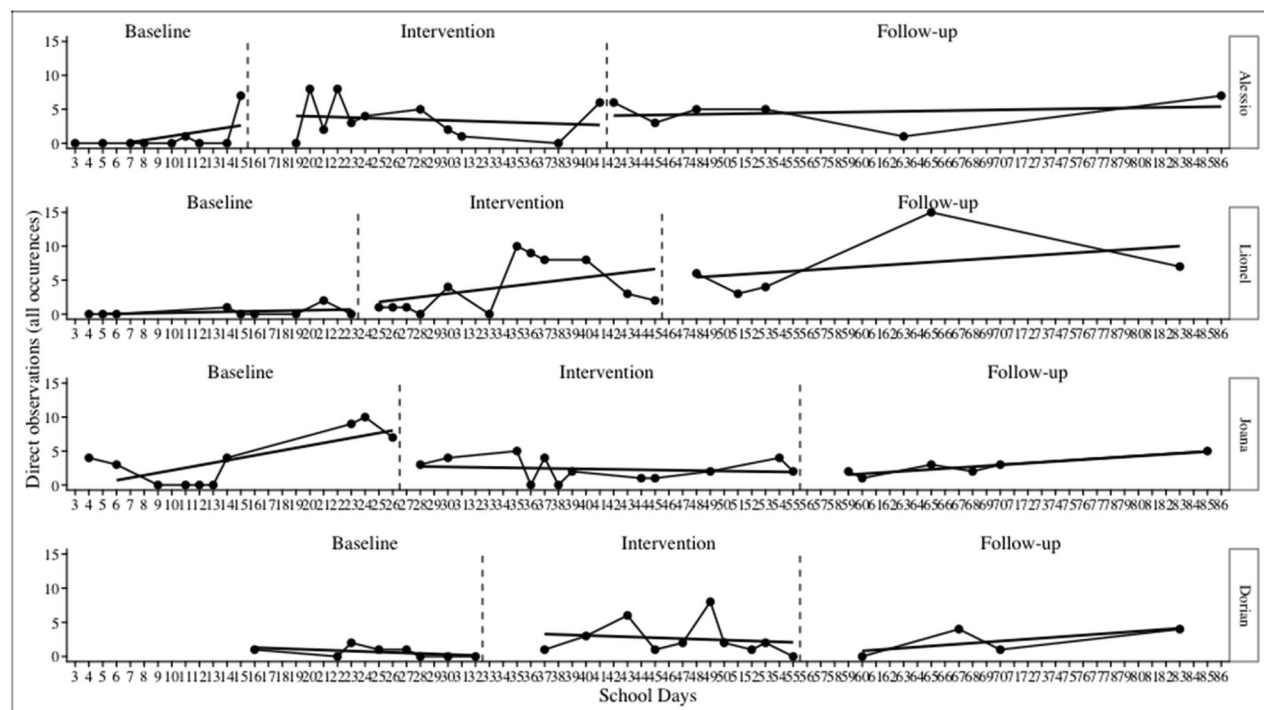


Figure 4. Direct observation of appropriate behaviours.

### Appropriate behaviours

Figure 3 and Figure 4 display all participants' IBRST and direct observation ratings for AB across baseline, intervention, and maintenance phases. Table 3 summarises the Tau-BC analyses examining changes in AB

across phases for each participant, as rated by teachers' IBRST and direct observers.

#### Alessio

During baseline, Alessio's AB, as rated on the IBRST, showed a low and stable trend. His mean score

increased from  $M=1.60$  (range = 1–3) during baseline to  $M=2.57$  (range = 1–4) during the intervention phase, reflecting a large effect ( $\tau=0.67$ ,  $p<0.001$ ). In the maintenance phase, the mean further increased to  $M=2.92$  (range = 2–4), reflecting a very large effect ( $\tau=0.91$ ,  $p<0.001$ ). These significant effects are complemented by visual analysis, which shows an increase during the intervention phase, followed by a reduction in variability during maintenance, suggesting a gradual rise in frequency that stabilises during the maintenance phase.

Direct observation data indicated that during the baseline phase, Alessio's AB occurred on average 0.9 times (range = 0–7). During the intervention phase, this mean increased to  $M=3.6$  occurrences (range = 0–8), reflecting a large effect ( $\tau=0.68$ ,  $p<0.05$ ). Alessio's AB further increased to 4.5 occurrences (range = 1–7) during maintenance, again reflecting a large effect ( $\tau=0.79$ ,  $p<0.05$ ). Although visual analysis shows a positive effect of intervention, a high variability can be noticed during the intervention phase.

### Lionel

During baseline, Lionel's AB, as rated on the IBRSST, showed an increasing trend, warranting trend correction in subsequent analyses. His mean score increased from  $M=2.45$  (range = 1–5) during baseline to  $M=4.55$  (range = 3–5) during the intervention phase, reflecting a moderate effect ( $\tau=0.47$ ,  $p<0.001$ ). In the maintenance phase, the mean further increased to  $M=4.82$  (range = 4–5), reflecting a moderate effect ( $\tau=0.34$ ,  $p<0.05$ ). These significant effects are complemented by visual analysis, which shows an increase during the intervention phase, followed by higher scores and lower variability during maintenance.

Direct observation data indicated that during the baseline phase, Lionel's AB occurred in average 0.33 occurrences (range = 0–2). During the intervention phase, this increased to  $M=3.92$  occurrences (range = 0–10), reflecting a large effect ( $\tau=0.77$ ,  $p<0.001$ ). Lionel's AB further increased to  $M=7.00$  occurrences (range = 3–15) during maintenance, reflecting a very large effect ( $\tau=1.00$ ,  $p<0.001$ ). Visual analysis supports these results by showing a steady uptrend across phases.

### Joana

During baseline, Joana's AB, as rated on the IBRSST, showed a low and stable trend. Her mean score increased from  $M=1.08$  (range = 1–2) during baseline to  $M=2.32$  (range = 1–5) during the

intervention phase, reflecting a large effect ( $\tau=0.69$ ,  $p<0.001$ ). In the maintenance phase, the mean further increased to 4.67 (range = 4–5), reflecting a very large effect ( $\tau=1.00$ ,  $p<0.001$ ). These significant effects are complemented by visual analysis, which shows an increase during the intervention phase, followed by a high score and low variability during maintenance.

Direct observation data indicated that during the baseline phase, Joana's AB occurred on average 3.70 occurrences (range = 0–10). During the intervention phase, it decreased to  $M=2.33$  occurrences (range = 0–5) and stayed stable with  $M=2.67$  occurrences (range = 1–5) during maintenance. Changes across phases were not significant.

### Dorian

During baseline, Dorian's AB, as rated on the IBRSST, showed a flat trend. His mean score stayed similar from baseline ( $M=2.12$ , range = 1–3) to the intervention phase ( $M=2.78$ , range = 1–5). In the maintenance phase, his mean increased to  $M=4.00$  (range = 2–5), reflecting a very large effect ( $\tau=0.85$ ,  $p<0.001$ ). These results are complemented by visual analysis, which shows flat trends during baseline and the intervention phase, with higher variability during intervention, while during maintenance the average was higher.

Direct observation data indicated that during the baseline phase, Dorian's AB was almost non-existent with an average 0.63 occurrences (range = 0–2). During the intervention phase, it increased to  $M=2.60$  occurrences (range = 0–8), reflecting a large effect ( $\tau=0.69$ ,  $p<0.05$ ). Dorian's AB slightly decreased to 2.25 occurrences (range = 0–4) during maintenance, without a significant effect. A high variability can be noticed during the intervention phase.

### Implementation fidelity

Average implementation fidelity of PTR intervention plan was 90% for Alessio across three sessions (79%, 93%, 100%), 89% for Lionel across two sessions (78%, 100%), and 94% for Joana across three sessions (88%, 96%, 100%). Please note that the percentages in parentheses represent session fidelity scores in chronological order. For Dorian, fidelity averaged 94% with one teacher across two sessions (93%, 95%), but only 31% with a second teacher who declined further coaching sessions. The disparities in implementation fidelity between Dorian's two part-time teachers are discussed further in the discussion. According to the external

PTR expert, the facilitator implemented the PTR process with 100% procedural integrity across all teams.

### Social validity

According to the TARF-R, the intervention was considered acceptable by all teachers, with average ratings ranging from 4.12 to 4.76 ( $M = 4.37$ ;  $SD = 1.00$ ;  $Md = 5$ ), suggesting that teachers generally found PTR goals, procedures, and outcomes acceptable. The median for only one item met the negative threshold. This item concerned the discomfort (stress, frustration, etc.) a student might experience related to PTR implementation ( $Md = 2.5$ ), which Alessio's and Dorian's teachers assessed as likely to occur.

### Discussion

The present study aimed to evaluate both the effectiveness and social validity of the PTR school-based model when implemented with students with IDD in special schools. The findings suggest that implementation of the programme was associated with an overall meaningful reduction in students' CB following completion of the PTR process (i.e. when comparing the baseline and maintenance phases). For two participants, this positive effect was observed on only one of the measures used (teachers' daily IBRST ratings for Lionel and the direct observations conducted by external observers for Alessio). A positive effect was observed on both measures for the two other students (Joana and Dorian) when comparing the baseline and maintenance phases. Implementation of the programme was also associated with an overall increase in participants' AB during the intervention and maintenance phases, as measured either by the IBRST completed by teachers or by short-length observations conducted by external observers for Joana and Dorian, or by both measures for Alessio and Lionel.

Caution is warranted in interpreting these findings because of the presence of baseline trends in some participants. In contrast to previous single-case studies, which generally reported stable baselines in CB (e.g. Barnes et al. 2020; DeJager and Filter 2015; Ford et al. 2024), our study showed variable baseline trends for several participants. Lionel was the only participant who showed a stable baseline of CB on the IBRST, while Dorian displayed an increase in CB. In contrast, both Alessio and Joana showed decreasing trends during the baseline phase on both the IBRST and direct observations. This suggests that discussing and defining CB, identifying AB, and asking staff to

observe and record data may have led to changes in teaching staff behaviour. Such changes could account for the decreasing trends in CB and the increasing trends in AB observed during the baseline phase for Joana (external observations) and Lionel (IBRST), even though no formal strategies had yet been introduced.

Variability was also high during the baseline and intervention phases for some students, on either one or both measures. This issue has likewise been noted by authors of other single-case studies examining PTR in school settings (e.g. Deenihan, Cho Blair, and Iovannone 2023; Sullivan et al. 2021). Joana and Dorian exhibited the greatest variability in CB during the intervention phase on both measures, though for different reasons. Joana's variability likely reflects the nature of her self-stimulatory behaviours, which are sensitive to environmental factors such as transitions, unclear structure, or crowded classrooms (Kirby et al. 2017). Dorian's variability may partly reflect differences in intervention implementation across the two teachers who co-taught his classroom, despite both receiving training and coaching in the use of the IBRST. Indeed, he was co-taught by two part-time teachers whose engagement with the PTR process differed markedly. While one teacher actively participated in PTR meetings and implemented the intervention plan with high fidelity, the other demonstrated limited engagement, was reluctant to modify established classroom practices, implemented the intervention with low fidelity, and declined additional coaching. This disparity in implementation fidelity highlights the importance of teacher buy-in and openness to professional support. Consistent with real-world school conditions, these findings suggest that, even when a structured intervention plan is provided, successful implementation depends not only on the quality of the intervention but also on teachers' engagement and willingness to adopt new practices.

Consistent with previous studies, the present findings support PTR effectiveness in reducing CB among participants (Barnes et al. 2020; Deenihan, Cho Blair, and Iovannone 2023; DeJager and Filter 2015; Ford et al. 2024; Strain, Wilson, and Dunlap 2011; Sullivan et al. 2021). While these previous studies were conducted with typically developing students or students with mild support needs, our findings suggest that the programme may also be beneficial for students with IDD and more extensive support needs. However, for some of these students, the effects of the intervention may take longer to become apparent and to consolidate. In previous studies (e.g. Ford et al. 2024),

intervention effects were typically immediate, whereas in our study, effects were often clearer and more pronounced during the maintenance phase, approximately 3 to 5 weeks after implementation of the intervention plan.

Discrepancies between the two behavioural measures used in this study may reflect differences in sensitivity; however, despite some variations between IBRST ratings and direct observation data, the overall trends across both measures were largely similar. Such discrepancies have also been reported in previous single-case studies using both measures (e.g. Sullivan et al. 2021). Although teacher ratings may be susceptible to bias compared with observations conducted by external observers, they can provide a more representative assessment of students' typical behaviour, as they capture behaviour across a longer time span. Moreover, Barnes et al. (2020) assessed the concurrent validity of the IBRST by comparing it with direct observation and reported 90% agreement ( $\kappa = 0.70$ ,  $p < 0.001$ ). These findings highlight the importance of using multiple data sources when evaluating intervention effects for students with IDD and extensive support needs, whose CB can vary substantially depending on environmental facilitators and obstacles.

Our findings suggest that teachers in special schools can implement PTR even without prior training or knowledge of PBS, as was the case in the present study. Indeed, implementation fidelity improved over time, likely reflecting the effects of ongoing coaching and increasing familiarity with the intervention strategies through practice. Regarding social validity, participants consistently reported very high levels of treatment acceptability, which aligns with previous research assessing PTR acceptability (Barnes et al. 2020; DeJager and Filter 2015; Ford et al. 2024; Iovannone et al. 2009). Some participants also reported potential discomfort experienced by students during implementation, which may be explained by the extinction burst phenomenon—that is, the temporary increase in CB intensity following withdrawal or modification of reinforcement contingencies (Catania 2013). Such effects of extinction procedures have been frequently documented in applied research using functional behaviour analysis (Fisher et al. 2023).

The study has several limitations. First, as is inherent to single-case designs, the small sample size limits the generalisability of the findings. Second, the presence of potential baseline autocorrelation highlights the need for careful methodological planning in

future studies and suggests the value of reflecting on how certain phases of the programme (e.g. goal setting and functional behaviour assessment) could be streamlined to better capture changes in students' behaviour. Indeed, downward trends in CB and upward trends in AB were observed at baseline for some participants, suggesting that programme components implemented prior to the formal intervention phase may have been sufficient to influence students' behaviour. These baseline trends weaken the internal validity of the design and the strength of the experimental demonstration of a functional relation between the intervention and changes in behaviour. Extending the baseline was not considered ethically appropriate because participants required timely support and the study was constrained by the school calendar. Third, limited data were collected on contextual factors such as classroom composition and staff experience, which could have provided richer details. Finally, as in previous research on PTR implementation in school settings, the present study employed a programme expert as facilitator. Although this approach ensured fidelity, it would be beneficial for the programme sustainability to examine its implementation when facilitated by someone external to the research team, rather than a researcher with extensive prior knowledge of the programme. Furthermore, future studies should systematically document barriers to implementation and reasons for discontinuing coaching, as this information could inform strategies to enhance intervention uptake and sustained implementation.

## Conclusion

This study suggests that structured, individualised PBS interventions targeting CB and promoting AB can be effectively implemented in special schools for students with IDD. Key factors contributing to success included co-construction of intervention strategies with teachers, ongoing facilitator support, and the integration of strategies into daily routines. These findings position programmes such as PTR as potentially powerful tools for supporting staff in special education schools in addressing CB in their students. While our findings appear promising, they should be interpreted with caution and confirmed through additional single-case studies and/or a randomised controlled trial. Given that this is, to the best of our knowledge, the first study implementing PTR with students with IDD in special schools, it is not possible to draw definitive conclusions regarding the effectiveness of the programme for these students.

Further research with students with high support needs remains essential.

## Acknowledgements

The authors would like to express their sincere thanks to all the staff and headteachers of the special schools who contributed to the realisation of this research.

## Ethics statement

This study was reviewed and deemed exempt from ethics approval by the Swiss Ethics Commission for Ethics in Human Research of Canton of Vaud with the reference number: 2024-0067720, due to the nature of the data that was collected. Informed consent was obtained from all participants and/or their legal guardians.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

This study was made possible through the support of the Swiss National Science Foundation [grant no. 100019-227842].

## ORCID

Zakaria Mestari  <http://orcid.org/0000-0003-3980-3591>  
Aline Veyre  <http://orcid.org/0000-0002-2518-5457>  
Rachel Sermier Dessemontet  <http://orcid.org/0000-0002-4295-3438>

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