Person- and Context-Specific Interventions Targeting Recurring Daily Stressors in Adults with Intellectual Disabilities in Residential Care: Five Single-Case AB Studies

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Abstract: *Background*: Recurring daily stressors embedded in residential care may contribute to challenging behavior and reduced emotional functioning in adults with intellectual disabilities. This study examined the development and preliminary evaluation of interventions targeting selected recurring daily stressors through idiographic theories of change.

Methods: Five adults with intellectual disabilities receiving long-term residential care were followed in repeated-measures single-case studies using an AB design. For each participant, an intervention team used structured case formulation to identify one recurring daily stressor, formulate an idiographic theory of change, and develop a person- and context-specific intervention aimed at modifying its frequency. This restores the accepted wording and corrects the grammatical error "at modify, perceived impact, or controllability. Target behavior, positive emotional functioning, and nocturnal heart rate variability, operationalized as pulse rate variability (PRV), were measured repeatedly and evaluated using visual inspection, Tau-U, and Bayesian regression models.

Results: Interventions were formulated for all five participants and carried out by the existing care teams, although implementation was delayed in two cases. Change could be evaluated for four participants. Target behavior improved in most cases: three showed a model-based indication of change in the expected direction, although this was not consistent across cases, and non-overlap reached significance only in Participant 1. Positive emotional functioning showed no consistent change. Nocturnal PRV likewise did not change consistently and decreased in Participant 5.

Conclusions: Recurring daily stressors can be addressed within everyday care by existing teams rather than only through individual treatment. Evidence for change after implementation was preliminary and clearest for target behavior.

Keywords: Intellectual disabilities, residential care, recurring daily stressors, chronic stressors, interventions, mental well-being, challenging behavior, single-case studies.

INTRODUCTION

People with intellectual disabilities living in residential care settings are frequently exposed to recurring daily stressors embedded in everyday care [1-4]. This exposure may contribute to emotional dysregulation and challenging behavior [3, 5, 6]. Because they are embedded in everyday care, recurring daily stressors can be difficult to recognize and even harder to change.

Many existing interventions targeting challenging behavior or emotional functioning in people with intellectual disabilities primarily focus on the individual, for example, through psychological therapies or pharmacological treatment, rather than on the recurring stressors present in everyday care [7-10]. Interventions that specifically target exposure to recurring daily stressors may therefore offer an important complementary approach alongside established context-sensitive approaches, including positive behavioral support, person-centered active support, and trauma-informed care [11-13]. This contextual focus may be especially relevant for people with intellectual disabilities, since interventions that rely strongly on an individual's cognitive appraisal or self-regulation strategies can be difficult to apply when cognitive processing and executive functioning are limited [14-16].

According to the transdisciplinary stress model proposed by Epel and colleagues [17], exposure to recurring stressors may lead to repeated activation of

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the stress system. When recovery between stress responses is insufficient, regulatory flexibility, the capacity of the stress system to return to baseline following activation, may become compromised, potentially affecting emotional and behavioral functioning. Over longer periods of time, repeated cycles of activation and insufficient recovery may contribute to cumulative physiological burden, often described as allostatic load, which has been associated with mental and physical health issues [18-21]. The present study examines the development of interventions that aim to modify exposure exposure to recurring daily stressors in residential care and provides a preliminary evaluation of changes in challenging behavior, positive emotional functioning, and physiological regulatory functioning in people with intellectual disabilities.

Previous work has conceptualized chronic stressors in residential care for people with intellectual disabilities as clusters of recurring daily stressors [4]. Exposure to such a stressor can be modified along three dimensions: frequency, perceived impact, or the person's control over it. Reducing frequency may limit cumulative physiological burden [17]; diminishing perceived impact may reduce immediate affective and behavioral responses [22]; and increasing control may buffer the effects of stress [17, 22]. Interventions targeting these dimensions can be both person-specific, in addressing a stressor relevant to an individual, and context-specific, in modifying exposure within that person's everyday care environment. Such interventions can be grounded in an idiographic theory of change: a case-specific account of how exposure to a recurring daily stressor may contribute to challenging behavior or lower positive emotional functioning and how modifying that stressor might produce change [23-25]. This stressor-focused approach complements functional behavioral approaches by making repeated exposure to a selected recurring daily stressor within everyday routines the explicit starting point for case formulation and intervention development [25, 26].

Changes following interventions targeting recurring daily stressors may occur at proximal and more distal levels. Because these interventions modify concrete situations in everyday care, changes may first become visible in proximal outcomes, such as challenging behavior and positive emotional functioning. Changes in the regulatory flexibility of the stress system, as indicated by heart rate variability, may be more distal.

The first proximal outcome concerns changes in challenging behavior. In individuals with intellectual disabilities, challenging behavior includes behaviors such as aggression, self-injury, or stereotyped behavior that may seriously affect the individual or others and limit participation in daily life [27]. Such behaviors are relatively common in residential care settings [26, 28, 29]. Within a stress-theoretical framework, challenging behavior may be understood as one possible behavioral manifestation of difficulties in stress regulation when individuals are exposed to stressors [17, 19].

The second proximal outcome concerns positive emotional functioning. Positive emotional functioning refers to observable signs of positive affect, enjoyment, and responsiveness in everyday situations. This is consistent with broader conceptualizations of positive well-being as involving both feeling good and functioning effectively [30]. From a stress-theoretical perspective, affective responses are part of the stress response, and low positive affect in response to daily stressors may indicate poor recovery from daily stress [17].

Heart rate variability (HRV) was included as a more distal physiological indicator of regulatory functioning. HRV refers to the variation in the time intervals between successive heartbeats [31, 32]. HRV is a widely accepted indicator of autonomic nervous system functioning that is often interpreted as reflecting the regulatory flexibility of the stress system [17, 33]. Physiological measures, including HRV, have been used in research on stress and challenging behavior in people with intellectual disabilities, often to examine physiological arousal in relation to specific incidents or situations [34, 35]. In this study, HRV was used not to capture acute physiological responses during such situations, but as an indicator of broader autonomic regulatory functioning and recovery during rest. During acute stress activation, HRV typically decreases and subsequently recovers, whereas HRV during nocturnal rest has been interpreted as reflecting the regulatory flexibility of the stress system [17, 32, 36]. Higher resting or nocturnal HRV has been associated with greater physiological adaptability and recovery following stress, whereas lower resting HRV has been linked to a reduced regulatory capacity [19, 32]. In particular, resting HRV measured upon awakening or during nocturnal rest may reflect the integrated regulatory state of the stress system following recent exposure to stressors, as autonomic activity during these periods is minimally influenced by situational demands [31, 32].

The present study was guided by two research questions. First, how were person- and context-specific interventions formulated and implemented in response to recurring daily stressors in everyday residential care? This question concerned the formulation of idiographic theories of change and the identification of modifiable dimensions of exposure to the selected stressor: frequency, perceived impact, and control. Second, what preliminary evidence of change was there after implementation in proximal outcomes, namely challenging behavior and positive emotional functioning, and in resting HRV as a more distal physiological indicator of regulatory functioning across five single-case studies? Changes in the expected direction were defined as lower target behavior and higher positive emotional functioning and nocturnal PRV; their magnitude and timing were examined within each case.

Because recurring daily stressors and their modification are highly individual and context-dependent, a single-case design was considered appropriate for the preliminary evaluation of these interventions. Single-case experimental designs are particularly useful for studying personalized interventions in heterogeneous populations and naturalistic care settings, including people with intellectual disabilities in residential care [37-39]. The present study applied this approach to interventions developed from idiographic theories of change in everyday residential care.

MATERIAL AND METHODS

Study Design

This study combined structured case formulation with a repeated-measures single-case AB design. The case-formulation procedure was used to develop a person- and context-specific intervention for each participant. The AB design allowed each intervention to be introduced once case formulation and local implementation preparations were complete, while repeated measurements enabled examination of levels and trends within each case across the baseline and intervention phases. During baseline (A), usual care continued; during the intervention phase (B), the case-specific intervention was implemented by the existing care team [37, 38].

Participants and Setting

Five adults with intellectual disabilities receiving long-term residential care participated in the study. Participants were eligible when they were aged 18 years or older, received 24-hour support under the Dutch Long-Term Care Act (Wet langdurige zorg), had a Dutch VG6 or VG7 care profile indicating very intensive residential support needs, and were known to display challenging behavior or difficulties in emotional functioning in daily life [40].

Recruitment was supported by the Dutch Centre for Consultation and Expertise (Centrum voor Consultatie en Expertise; CCE). Consultants within its national network identified individuals who might meet the eligibility criteria and facilitated contact between the research team and the behavioral specialists responsible for their care. Behavioral specialists from four care organizations subsequently made the formal referrals. After referral, the research team assessed feasibility, including whether the participant was expected to tolerate the Empatica EmbracePlus (Empatica Inc., Cambridge, MA, USA), whether the care team could complete repeated measurements, and whether the team could implement a case-specific intervention within everyday care.

The study was conducted in five 24-hour residential care settings across four organizations. Residential setting, group size, and usual support arrangements differed between participants and are reported in Table **1**.

Based on clinical records, two participants had moderate, and three had severe intellectual disabilities. Adaptive functioning was estimated using a Dutch translation of the Vineland Screener 0–12 years research version [41, 42], completed by a caregiver. Descriptive use of this screener in adults with intellectual disabilities has been reported previously [29]. Psychiatric diagnoses were not systematically extracted from clinical records for research purposes and are therefore not reported as participant characteristics. Participant and residential setting characteristics are summarized in Table **1**.

Prior to participation, informed consent was obtained from participants or, when they were unable to provide consent themselves, from their legal representatives. Where possible, participation was discussed with the participants themselves using accessible information. The study protocol was reviewed and approved by the Ethics Review Committee of the Faculty of Social and Behavioural Sciences at Utrecht University and filed under number 24-0308.

Table 1: Participant and Residential Setting Characteristics

Participant	Age (y)	Gender	ID level	Adaptive age (y;m)	Care profile	Setting	Group size and usual support
1	37	F	Severe	3y;4m	VG7	Individual apartment	1 resident; one-to-one support
2	25	M	Moderate	4y;7m	VG6	Group home in residential neighborhood	6 residents; 1 staff member per shift
3	31	M	Severe	3y;4m	VG7	Group home on residential care site	5 residents; one-to-one support for the participant
4	24	F	Severe	3y;1m	VG7	Group home on residential care site	6 residents; 2 staff members per shift
5	27	M	Moderate	4y;10m	VG7	Clustered apartments in residential neighborhood	6 residents; 2–3 staff members per shift

Note. ID = intellectual disability. Adaptive age refers to the adaptive age-equivalent estimated using the Vineland Screener. y = years; m = months; F = female; M = male; VG = Dutch residential care profile.

Procedure

Data were collected during a baseline phase followed by an intervention phase. The intended study duration was 12 weeks, comprising a 4-week baseline phase and an 8-week intervention phase [37, 38]. In practice, phase lengths varied between cases because interventions could start only after case-specific formulation and practical implementation planning had been completed. Participant flow and case-specific study timelines are presented in Figure **1**.

During baseline, usual care continued, repeated measurements were collected, and case formulation was conducted. During the intervention phase, the existing care team implemented the intervention while repeated measurements continued.

Before data collection began, direct support workers received a written manual describing the study procedures, the use of the wearable device, and completion of the daily ratings. Staff-reported ratings were entered digitally in Qualtrics (Qualtrics, Provo, UT, USA). At the end of the study period, the primary direct support worker reviewed the participant's daily reports with the first author to identify relevant contextual events not fully captured in the rating forms, such as illness, incidents involving other residents, changes in routines, or temporary absence of familiar staff members [37].

Case Formulation and Intervention Development

For each participant, a small intervention team was formed comprising the behavioral specialist, the primary direct support worker, and the first author. Drawing on case formulation approaches, the first author guided the team through three steps: defining the case problem, formulating an idiographic theory of change, and selecting a case-specific intervention [25, 43].

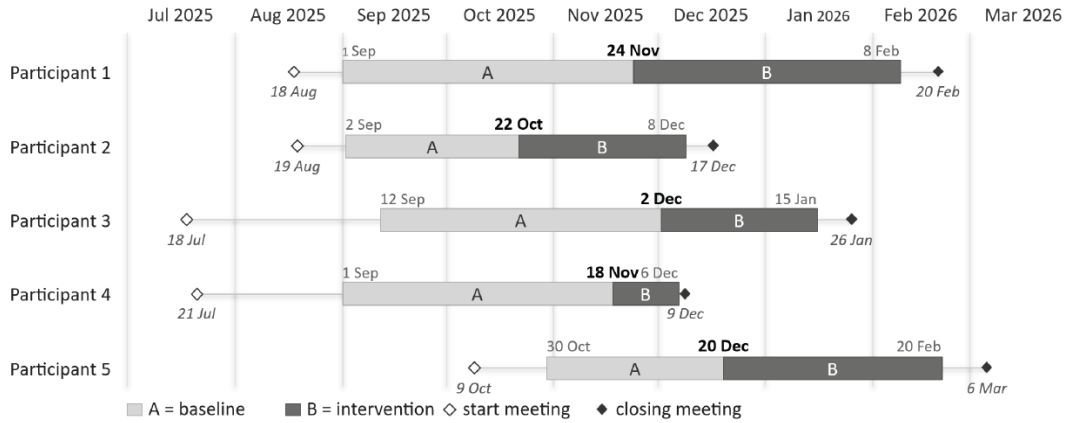

Figure 1: Participant flow and case-specific study timelines.

Note. A = baseline phase; B = intervention phase. The open marker indicates the start meeting and the filled marker the closing meeting, with the dates shown in between, with the dates shown in between.

First, the team identified the main issue in challenging behavior or emotional functioning and selected the recurring daily stressor most plausibly linked to it. This was based on the BPI-S [44], routine care reports, professional knowledge from the behavioral specialist and direct support workers, and the stressor clusters and chronic stressor inventory developed in previous work on chronic stressors in residential care [4, 6].

Second, drawing on the transdisciplinary stress model described by Epel and colleagues [17], the team formulated how the selected recurring daily stressor was expected to contribute to the case problem, taking into account participant characteristics, stress responses, and the everyday care context.

Third, the team developed a person- and context-specific intervention aimed at modifying exposure to the selected recurring daily stressor by reducing its frequency, reducing its perceived impact, or increasing the participant's control over it. The intervention was implemented by the existing care team. Before implementation, the intervention team specified how it would be incorporated into everyday support and communicated this to staff, typically through the written daily support program and discussion during a team meeting. During implementation, the primary direct support worker checked whether the procedures were being applied and were workable in practice and discussed implementation problems during weekly contact with the research team.

MATERIALS AND MEASURES

Challenging Behavior

Challenging behavior was recorded daily using the Behavior Problems Inventory - Short Form [BPI-S; 44], which distinguishes three subscales: self-injurious behavior, aggressive/destructive behavior, and stereotyped behavior. For each participant, the form included BPI-S items describing behaviors known to occur, as well as space to report any additional behaviors observed during the shift. At the end of each shift, direct support workers recorded whether each behavior had occurred and rated its frequency and severity. During case formulation, target behavior was defined as all items from the BPI-S subscale(s) most clearly linked to the selected recurring daily stressor. Because the original BPI-S frequency scale refers to behavior over a longer period, frequency was adapted to shift-level anchors: 0 = did not occur, 1 = once, 2 = several times, and 3 = very often or continuously. Severity was rated on a scale of 1 = mild, 2 = moderate, and 3 = severe. In line with Bowring and colleagues [28], behaviors occurring 2 or more times were counted as incidents regardless of severity; behaviors occurring once were counted as incidents only when severity was moderate or severe. Incidents were summed per shift.

Positive Emotional Functioning

Positive emotional functioning was assessed using daily observer ratings completed by direct support workers. Because internal states such as mood or emotional well-being cannot be directly observed and are difficult to assess through self-report in adults with moderate to severe intellectual disabilities, ratings focused on observable signs of positive emotional functioning [45]. At the end of each shift, direct support workers rated their overall impression of the participant's positive emotional functioning, considering general signs such as facial expression, vocalizations, posture, social responsiveness, and engagement in activities, as specified for each participant. Ratings were recorded on a 1–10 numerical rating scale, a format commonly used for brief unidimensional ratings [46]. Before daily ratings began, the intervention team defined participant-specific anchors for scores 1 and 10, based on observable behaviors indicating very low and very high positive emotional functioning in daily care.

Nocturnal Pulse Rate Variability

HRV was operationalized as pulse rate variability (PRV) derived from photoplethysmography signals collected during sleep with the Empatica EmbracePlus, a wrist-worn device [47]. Because the device derives variability from pulse signals rather than electrocardiography, the analyzed physiological variable is referred to as PRV. Depending on the participant, direct support workers placed the device on the wrist or assisted participants in putting it on themselves. The device provides vendor-derived minute-level PRV values based on the root mean square of successive differences (RMSSD), calculated in non-overlapping 60-second windows after internal removal of motion artifacts. For analysis, nocturnal PRV values were based on recordings between 03:00 and 06:00 [31, 32]. Nights were included when at least 30% of minutes in this window contained valid PRV estimates. The median of valid minute-level PRV values was used as the nightly estimate of resting autonomic regulation.

Data Analysis

Case Formulation and Implementation Data

Case problems were classified by selected BPI-S subscale(s), selected recurring daily stressors by their stressor clusters, and interventions by intended change: frequency, perceived impact, or control. Implementation information relevant to interpreting change was extracted from weekly care-team contact and research-team notes.

Missing Data

Participant 4 was excluded from statistical evaluation because delayed implementation left only 18 intervention-phase days and too few questionnaire observations. For the remaining four participants, analyses used all available questionnaire observations and nocturnal PRV estimates; missing values were not imputed. Missing questionnaire observations clustered during particular shifts and periods of absence from the residential setting, including weekend family visits, and were therefore not assumed to be completely at random [48]. Missing PRV values represented nights in which fewer than 30% of minutes between 03:00 and 06:00 contained valid PRV estimates, often because movement or wakefulness reduced signal quality. Across analyzed participants, missingness ranged from 18% to 42% for questionnaire observations and from 8% to 60% for PRV, with the highest PRV proportion in Participant 2. No separate sensitivity analyses for missing data were performed.

Statistical Analysis

Statistical assumptions were inspected before analysis. Nocturnal PRV was log-transformed to improve model fit. Transformations of target behavior and positive emotional functioning did not improve model fit and were not applied to preserve interpretability. Before final analysis, outlying observations with disproportionate influence on fitted trend lines (Pareto $k > 0.7$) were inspected. Four such observations were excluded from the corresponding analyses, as supported by visual inspection. Analyses were conducted in R version 4.4.1 (2024-06-14) [49]. Target behavior, positive emotional functioning, and nocturnal PRV were evaluated between baseline and intervention phases. Questionnaire observations were plotted and analyzed according to their actual date and time of reporting; nocturnal PRV values were indexed by night and analyzed as a sequence of nightly observations. For participants whose target behavior or expected intervention effect concerned a specific part of the day, analyses were restricted to observations from that case-specific target period, such as the evening.

Analyses combined three approaches. First, time-series plots were visually inspected for level, trend, variability, overlap, and immediacy of change, and descriptive statistics were calculated for each phase [37-39]. Second, Tau-U provided a rank-based summary of how consistently intervention-phase observations were more favorable than baseline observations, with correction for baseline trend [50]. Tau-U was calculated using singlecaseresearch.org [51]. Finally, Bayesian regression models were fitted separately for each participant and outcome variable to estimate phase-related differences in level, within-phase trends, and Time × Phase interactions, and to quantify uncertainty in these estimates [52, 53]. Thus, Tau-U summarized ordinal separation between phases, whereas the regression models characterized the form and uncertainty of change over time. The two quantitative approaches were interpreted together, and discrepancies were retained in the case-specific interpretation.

For the Bayesian regression models, Phase, Time within phase, and the Time × Phase interaction were entered as predictors. Phase was the prespecified indicator of phase-related differences in level; Time and Time × Phase provided supplementary information on within-phase trends and differences in trend between phases. Time was based on the actual date and time of each observation and centered within each phase, with the midpoint coded as 0 and observations expressed in weeks from this midpoint. For questionnaire outcomes, adding the rater as a predictor did not improve model fit; the more parsimonious model was therefore retained. Autoregressive terms were not included because missing observations and irregular measurement intervals limited their reliable incorporation.

RESULTS

Results are presented by participant and follow the two research questions: first, case formulation and intervention; and second, evaluation of change in case-specific challenging behavior, positive emotional functioning, and nocturnal PRV. For the four participants for whom change could be evaluated, Figures **2-5** show the repeated outcome measurements, and Tables **2-5** summarize the descriptive statistics, Tau-U results, and report the Bayesian regression estimates.

Participant 1

Case Formulation and Intervention.

Problem

Participant 1 showed stereotyped behavior, especially repetitive manipulation and checking of objects; interruption could lead to emotional escalation.

Stressor

The selected recurring daily stressor was unpredictability during daily activities and transitions, within the cluster "Exposure to unexpected situations".

Idiographic Theory of Change

The team formulated that unclear transitions kept the participant alert to what might happen next, and that ordering behavior functioned as an attempt to create predictability and control.

Intervention

To increase control and reduce the impact of transitions, a fixed transition chair was introduced, and direct support workers used concrete object cues to announce upcoming activities.

Implementation

Implementation was delayed by approximately 1 month due to the participant's primary direct support worker becoming ill.

Evaluation of Change

Stereotyped Behavior

The median score for stereotyped behavior was lower during the intervention phase than during baseline. Tau-U was statistically significant in the expected direction. The Bayesian model similarly indicated lower stereotyped behavior during the intervention phase and a gradual decrease over time within phases. The model did not indicate a Time × Phase interaction (Figure **2a**; Table **2**).

Positive Emotional Functioning

The median score for positive emotional functioning was higher during the intervention phase than during

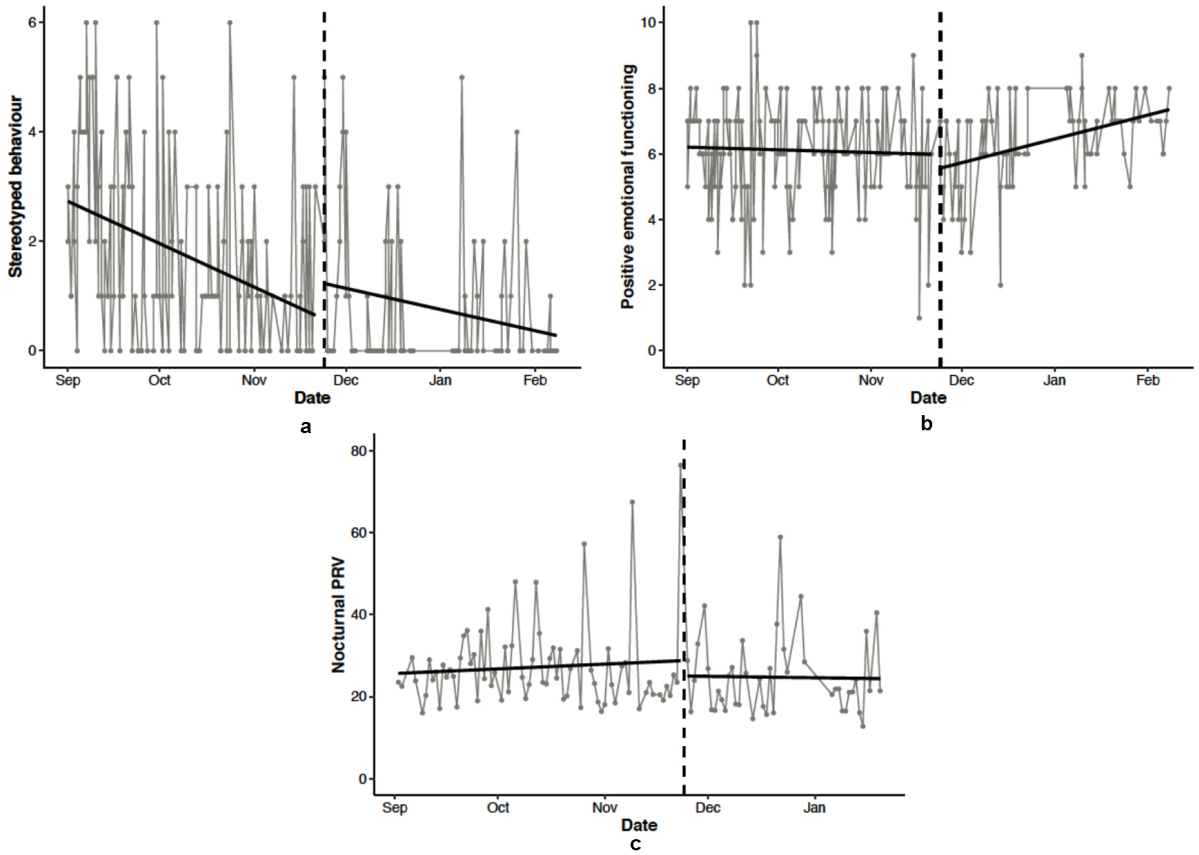

Figure 2: Repeated measurements for Participant 1 across baseline and intervention phases for (**a**) stereotyped behavior, (**b**) positive emotional functioning, and (**c**) nocturnal PRV.

Note. The vertical dashed line indicates the start of the intervention phase. Dots represent individual observations. Solid lines indicate fitted trend lines within the baseline and intervention phases.

Table 2: Descriptive, Tau-U, and Bayesian Regression Results for Participant 1

Panel A. Descriptive and Tau-U results				
Outcome	**Baseline Mdn (IQR), n**	**Intervention Mdn (IQR), n**	**τ_u**	***p***
Stereotyped behavior	1 (0–3), 135	0 (0–1), 80	-0.16	.047
Positive emotional functioning	6 (5–7), 135	7 (6–7), 80	0.13	.115
Nocturnal PRV	24.4 (20.5–29.4), 72	21.8 (17.2–27.8), 43	-0.12	.257
Panel B. Bayesian regression estimates				
Outcome	**Predictor**	**Estimate**	**Est. Error**	**95% CrI**
Stereotyped behavior	Intercept	1.78	0.13	[1.53, 2.04]
	Time	**-0.18**	**0.04**	**[-0.25, -0.11]**
	Phase	**-0.91**	**0.22**	**[-1.34, -0.48]**
	Time × Phase	0.09	0.06	[-0.03, 0.21]
Positive emotional functioning	Intercept	6.11	0.13	[5.86, 6.37]
	Time	-0.02	0.04	[-0.09, 0.05]
	Phase	0.12	0.21	[-0.30, 0.54]
	Time × Phase	**0.18**	**0.06**	**[0.06, 0.30]**
Nocturnal PRV	Intercept	3.20	0.03	[3.13, 3.27]
	Time	-0.01	0.01	[-0.03, 0.01]
	Phase	-0.09	0.06	[-0.20, 0.03]
	Time × Phase	-0.00	0.02	[-0.05, 0.04]

Note. Nocturnal PRV values in Panel A are presented on the original scale; Bayesian regression estimates for nocturnal PRV in Panel B are based on log-transformed values. Bold predictors indicate model-based indications of association, defined as 95% credible intervals that do not include zero.

baseline. Tau-U was not statistically significant. The Bayesian model did not indicate a phase-related difference or an association with Time, but indicated that change over time differed between phases (Figure **2b**; Table **2**).

Nocturnal PRV

Median nocturnal PRV was lower during the intervention phase than during baseline. Tau-U was not statistically significant. The Bayesian model did not indicate an association with Phase, Time, or the Time × Phase interaction (Figure **2c**; Table **2**).

Taken together, the findings for Participant 1 indicated lower stereotyped behavior during the intervention phase. Positive emotional functioning and nocturnal PRV did not show clear phase-related improvement.

Participant 2

Case Formulation and Intervention

Problem

Participant 2 showed stereotyped behavior during the late shift (defined as the period after 15:00): repetitive movements and vocal behavior during unstructured time after dinner.

Stressor

The selected recurring daily stressor was unstructured time after dinner without sufficient supportive contact, within the cluster “Being without people you are used to and trust”.

Idiographic Theory of Change

The team formulated that unstructured evening time increased arousal and made it harder for the participant

to settle. Predictable activity and co-regulation were expected to prevent this build-up of restlessness.

Intervention

To reduce unstructured time alone, increase predictability, and decrease stereotyped behavior during the late shift, activity schedules and pictorial supports were used to structure evening activities, including small household tasks carried out with a direct support worker.

Implementation

Implementation proceeded as planned, although one day-activity setting closed during the intervention phase, leaving the participant at home two days per week.

Evaluation of Change

Stereotyped Behavior

The median score for stereotyped behavior was lower during the intervention phase than during baseline. Tau-U was not statistically significant. The Bayesian model indicated lower stereotyped behavior during the intervention phase. The model did not indicate an association with Time or the Time × Phase interaction (Figure **3a**; Table **3**).

Positive Emotional Functioning

The median score for positive emotional functioning was higher during the intervention phase than during baseline. Tau-U was not statistically significant. The Bayesian model did not indicate an association with Phase, Time, or the Time × Phase interaction (Figure **3b**; Table **3**).

Nocturnal PRV

Median nocturnal PRV was lower during the intervention phase than during baseline. Tau-U was not statistically significant. The Bayesian model did not indicate an association with Phase, Time, or the Time × Phase interaction (Figure **3c**; Table **3**).

Taken together, the findings for Participant 2 indicated lower stereotyped behavior during the intervention phase. Positive emotional functioning was descriptively higher, but the model did not indicate a phase-related difference. Nocturnal PRV did not improve during the intervention phase.

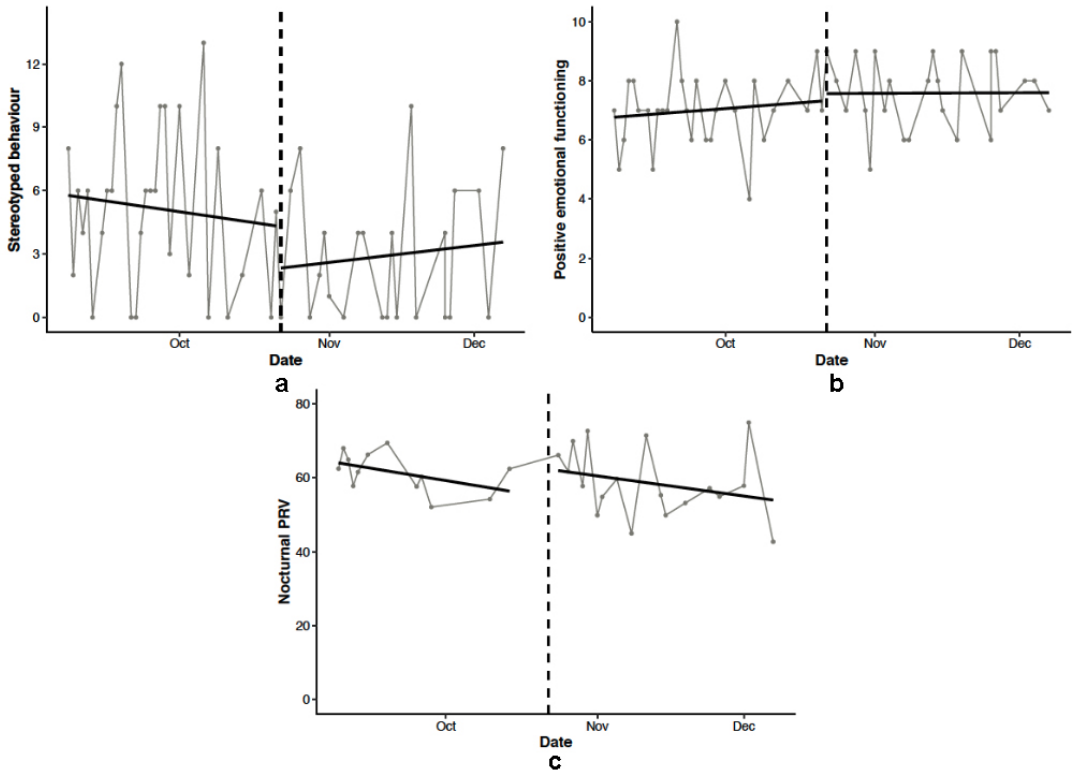

Figure 3: Repeated measurements for Participant 2 across baseline and intervention phases for (**a**) stereotyped behavior, (**b**) positive emotional functioning, and (**c**) nocturnal PRV.

Note. The vertical dashed line indicates the start of the intervention phase. Dots represent individual observations. Solid lines indicate fitted trend lines within the baseline and intervention phases.

Table 3: Descriptive, Tau-U, and Bayesian Regression Results for Participant 2

Panel A. Descriptive and Tau-U results				
Outcome	**Baseline Mdn (IQR), n**	**Intervention Mdn (IQR), n**	**τ_u**	***p***
Stereotyped behavior	6 (2–7.5), 30	2 (0–5), 23	-0.31	.052
Positive emotional functioning	7 (6.25–8), 30	8 (7–9), 24	0.22	.169
Nocturnal PRV	62.0 (57.8–65.3), 12	57.5 (53.6–65.1), 18	-0.20	.276
Panel B. Bayesian regression estimates				
Outcome	**Predictor**	**Estimate**	**Est. Error**	**95% CrI**
Stereotyped behavior	Intercept	5.23	0.69	[3.91, 6.56]
	Time	-0.25	0.38	[-1.01, 0.52]
	Phase	**-2.32**	**1.04**	**[-4.38, -0.26]**
	Time × Phase	0.44	0.55	[-0.68, 1.46]
Positive emotional functioning	Intercept	6.97	0.24	[6.52, 7.43]
	Time	0.09	0.13	[-0.16, 0.35]
	Phase	0.60	0.35	[-0.09, 1.28]
	Time × Phase	-0.08	0.19	[-0.46, 0.28]
Nocturnal PRV	Intercept	4.10	0.04	[4.02, 4.19]
	Time	-0.03	0.03	[-0.08, 0.03]
	Phase	-0.05	0.05	[-0.16, 0.06]
	Time × Phase	0.00	0.03	[-0.06, 0.06]

Note. Nocturnal PRV values in Panel A are presented on the original scale; Bayesian regression estimates for nocturnal PRV in Panel B are based on log-transformed values. Bold predictors indicate model-based indications of association, defined as 95% credible intervals that do not include zero.

Participant 3

Case Formulation and Intervention

Problem

Participant 3 exhibited stereotyped behavior, particularly repetitive manipulation of objects and prolonged visual fixation on details in shared spaces.

Stressor

The selected recurring daily stressor was exposure to intense visual stimuli, within the cluster “Being exposed to intense sensory experiences”.

Idiographic Theory of Change

The team formulated that visually salient details increased arousal by drawing the participant’s attention. Proprioceptive input was expected to redirect attention and support regulation.

Intervention

To reduce the impact of visual stimulation and decrease stereotyped behavior during the late shift, direct support workers offered a daily basketball activity involving catching, throwing, and coordinated movement.

Implementation

The activity was initially offered at a fixed time but later offered more flexibly in the afternoon, when fixed timing led to refusals.

Evaluation of Change

Stereotyped Behavior

The median score for stereotyped behavior was the same in both phases, although non-zero scores occurred mainly during baseline. Tau-U was not statistically significant. The Bayesian model indicated

lower stereotyped behavior during the intervention phase. The model did not indicate an association with Time or the Time × Phase interaction (Figure **4a**; Table **4**).

Positive Emotional Functioning

The median score for positive emotional functioning was the same in both phases, although scores were generally higher during the intervention phase. Tau-U was statistically significant in the expected direction. The Bayesian model did not indicate an association with Phase, Time, or the Time × Phase interaction (Figure **4b**; Table **4**).

Nocturnal PRV

Median nocturnal PRV was higher during the intervention phase than during baseline. Tau-U was statistically significant in the expected direction. The Bayesian model indicated a decrease over time within phases but did not indicate an association with Phase or the Time × Phase interaction (Figure **4c**; Table **4**).

Taken together, the findings for Participant 3 indicated lower stereotyped behavior during the intervention phase. Positive emotional functioning and nocturnal PRV showed higher intervention-phase scores and statistically significant Tau-U results, but the Bayesian models did not indicate phase-related differences.

Participant 4

Case Formulation and Intervention

Problem

Participant 4 exhibited aggressive/destructive behavior before meals, including destroying objects.

Stressor

The selected recurring daily stressor was waiting for meals without being able to influence the timing, within the cluster “Facing restrictions in options and choices”.

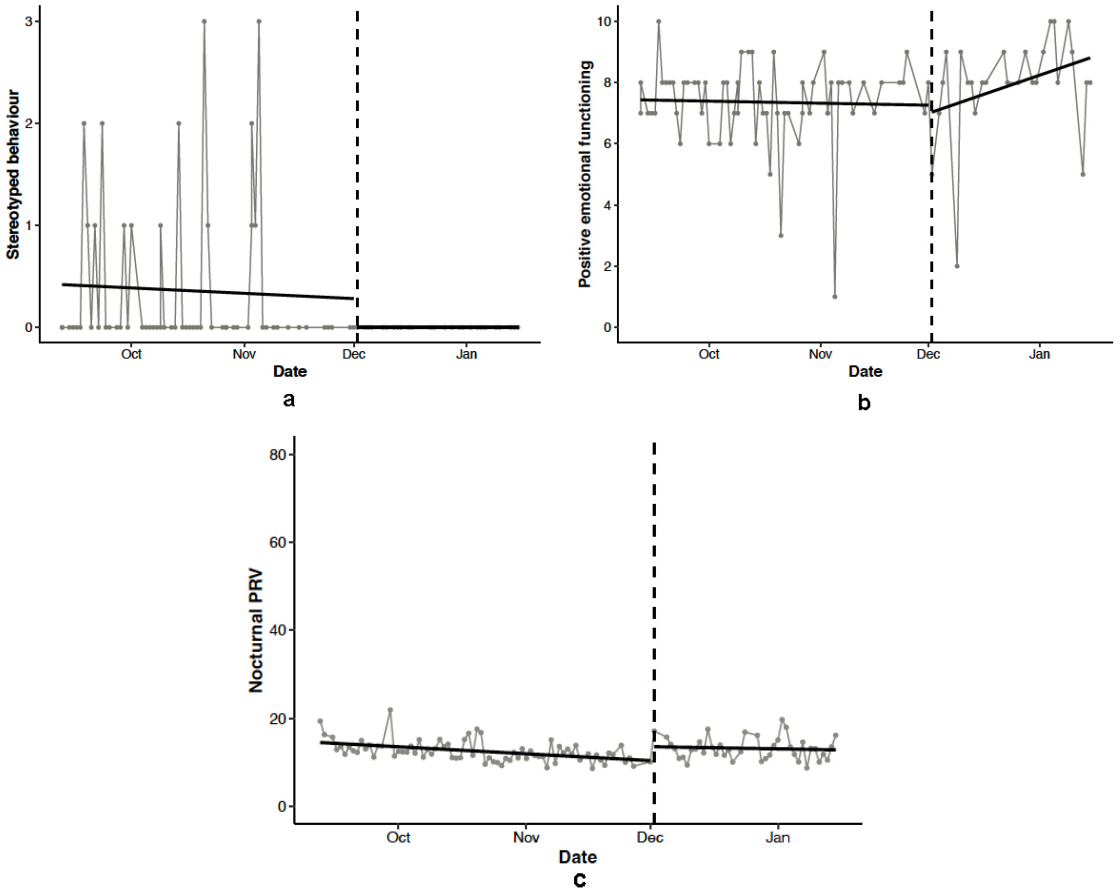

Figure 4: Repeated measurements for Participant 3 across baseline and intervention phases for (**a**) stereotyped behavior, (**b**) positive emotional functioning, and (**c**) nocturnal PRV.

Note. The vertical dashed line indicates the start of the intervention phase. Dots represent individual observations. Solid lines indicate fitted trend lines within the baseline and intervention phases.

Table 4: Descriptive, Tau-U, and Bayesian Regression Results for Participant 3

Panel A. Descriptive and Tau-U results				
Outcome	**Baseline Mdn (IQR), n**	**Intervention Mdn (IQR), n**	**τ_u**	***p***
Stereotyped behavior	0 (0–0), 62	0 (0–0), 25	-0.19	.170
Positive emotional functioning	8 (7–8), 62	8 (8–9), 25	0.31	.021
Nocturnal PRV	12.1 (11.0–13.7), 75	13.0 (11.5–14.6), 39	0.47	< .001
Panel B. Bayesian regression estimates				
Outcome	**Predictor**	**Estimate**	**Est. Error**	**95% CrI**
Stereotyped behavior	Intercept	0.36	0.08	[0.20, 0.51]
	Time	-0.01	0.03	[-0.06, 0.04]
	Phase	**-0.36**	**0.15**	**[-0.65, -0.06]**
	Time × Phase	0.01	0.07	[-0.12, 0.15]
Positive emotional functioning	Intercept	7.37	0.19	[7.00, 7.74]
	Time	-0.02	0.06	[-0.13, 0.10]
	Phase	0.58	0.35	[-0.10, 1.26]
	Time × Phase	0.30	0.16	[-0.03, 0.63]
Nocturnal PRV	Intercept	2.55	0.02	[2.50, 2.59]
	Time	**-0.02**	**0.01**	**[-0.04, -0.01]**
	Phase	-0.00	0.04	[-0.08, 0.07]
	Time × Phase	0.01	0.02	[-0.03, 0.04]

Note. Nocturnal PRV values in Panel A are presented on the original scale; Bayesian regression estimates for nocturnal PRV in Panel B are based on log-transformed values. Bold predictors indicate model-based indications of association, defined as 95% credible intervals that do not include zero.

Idiographic Theory of Change

The team formulated that waiting for meals led the participant to focus on sounds and movements around the kitchen, increasing arousal and overstimulation. Destructive behavior was understood as an expression of heightened tension.

Intervention

To reduce the impact of waiting, a direct support worker created a shared focus of attention by reading a book with visual and tactile features with the participant before meals.

Implementation

Implementation was delayed because the book was not immediately available, so the intervention started late in the intervention phase.

Evaluation of Change

Due to delayed implementation and substantial missing data, no evaluation of change was possible for this participant.

Participant 5

Case Formulation and Intervention

Problem

Participant 5 showed aggressive/destructive and stereotyped behavior during the late shift, especially verbal aggression within conflictual interactions with direct support workers.

Stressor

The selected recurring daily stressor was recurring staff-directed demands that restricted the participant's

options and choices, mainly within the cluster “Facing restrictions in options and choices” and related to “Being dependent on direct support workers by influencing the shaping of one's life”.

Idiographic Theory of Change

The team found that staff-directed demands reduced the participant’s sense of control, especially when contact with direct support workers occurred mainly during correction, persuasion, or unwanted demands. This increased the impact of everyday demands and contributed to verbal escalation.

Intervention

To increase control, reduce the impact of staff-directed demands, and decrease challenging behavior during the late shift, a fixed supportive contact moment was introduced at the start of the shift to discuss the daily program, plan upcoming tasks, and, when needed, prepare or carry out tidying together.

Implementation

Implementation proceeded well, although several serious personal and relational events occurred during the intervention phase and may have affected behavioral and emotional functioning.

Evaluation of Change

Aggressive/Destructive and Stereotyped Behavior

The median score for aggressive/destructive and stereotyped behavior was lower during the intervention phase than during baseline. Tau-U was not statistically significant. The Bayesian model did not indicate an association with Phase, Time, or the Time × Phase interaction (Figure **5a**; Table **5**).

Positive Emotional Functioning

The median score for positive emotional functioning was higher during the intervention phase than during baseline. Tau-U was not statistically significant. The Bayesian model did not indicate an association with Phase, Time, or the Time × Phase interaction (Figure **5b**; Table **5**).

Nocturnal PRV

Median nocturnal PRV was lower during the intervention phase than during baseline. Tau-U was statistically significant in the unexpected direction. The

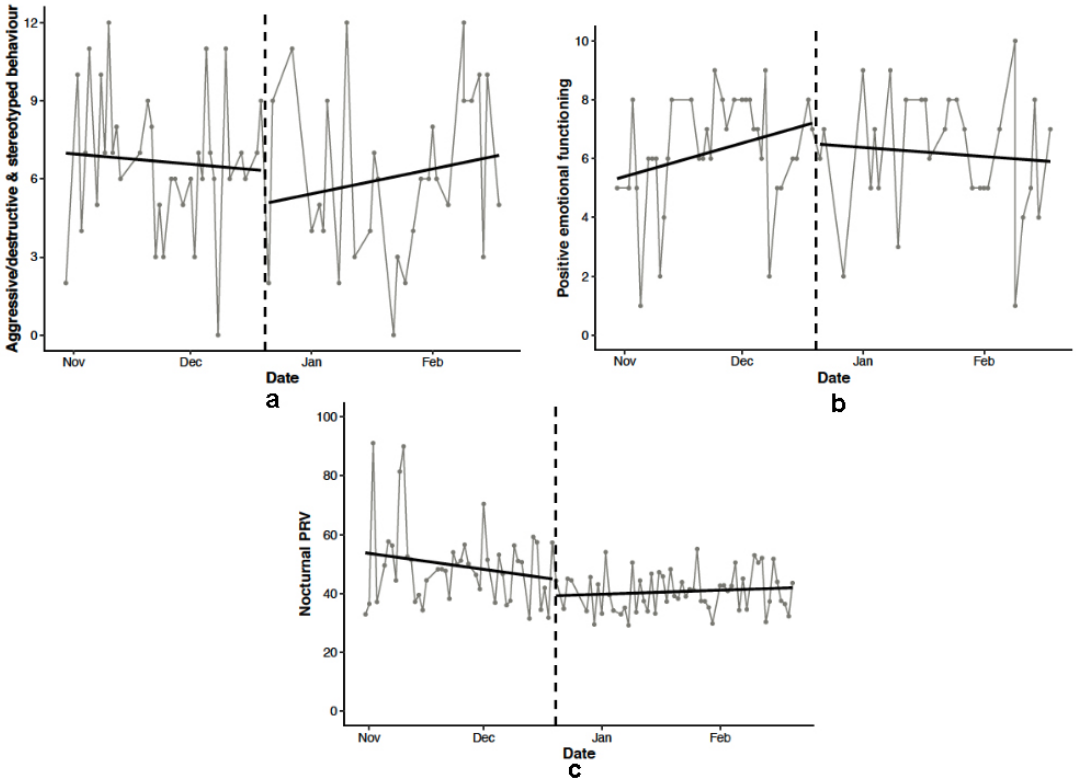

Figure 5: Repeated measurements for Participant 5 across baseline and intervention phases for (**a**) aggressive/destructive and stereotyped behavior, (**b**) positive emotional functioning, and (**c**) nocturnal PRV.

Note. The vertical dashed line indicates the start of the intervention phase. Dots represent individual observations. Solid lines indicate fitted trend lines within the baseline and intervention phases.

Table 5: Descriptive, Tau-U, and Bayesian Regression Results for Participant 5

Panel A. Descriptive and Tau-U results				
Outcome	**Baseline Mdn (IQR), n**	**Intervention Mdn (IQR), n**	**τ_u**	***p***
Aggressive/destructive and stereotyped behavior	7 (5.5–8), 35	6 (4–9), 29	-0.13	.370
Positive emotional functioning	6 (5.5–8), 35	7 (5–8), 29	-0.15	.302
Nocturnal PRV	48.9 (38.0–54.6), 45	40.1 (34.8–45.0), 55	-0.41	< .001
Panel B. Bayesian regression estimates				
Outcome	**Predictor**	**Estimate**	**Est. Error**	**95% CrI**
Aggressive/destructive and stereotyped behavior	Intercept	6.64	0.51	[5.64, 7.64]
	Time	-0.09	0.25	[-0.58, 0.40]
	Phase	-0.54	0.77	[-2.10, 0.95]
	Time × Phase	0.31	0.34	[-0.37, 0.98]
Positive emotional functioning	Intercept	6.26	0.34	[5.59, 6.94]
	Time	0.27	0.16	[-0.05, 0.59]
	Phase	-0.09	0.51	[-1.09, 0.91]
	Time × Phase	-0.33	0.22	[-0.77, 0.10]
Nocturnal PRV	Intercept	3.92	0.03	[3.85, 3.98]
	Time	**-0.03**	**0.02**	**[-0.07, -0.00]**
	Phase	**-0.24**	**0.05**	**[-0.33, -0.14]**
	Time × Phase	0.04	0.02	[-0.00, 0.08]

Note. Nocturnal PRV values in Panel A are presented on the original scale; Bayesian regression estimates for nocturnal PRV in Panel B are based on log-transformed values. Bold predictors indicate model-based indications of association, defined as 95% credible intervals that do not include zero.

Bayesian model similarly indicated lower nocturnal PRV during the intervention phase and a decrease over time within phases. The model did not indicate a Time × Phase interaction (Figure **5c**; Table **5**).

Taken together, aggressive/destructive and stereotyped behavior and positive emotional functioning changed descriptively in the expected direction, but the Bayesian models did not indicate phase-related differences. Nocturnal PRV decreased during the intervention phase, in the opposite direction of the expected effect.

Cross-Case Summary

Across the five cases, intervention teams formulated person- and context-specific interventions targeting selected recurring daily stressors, grounded in idiographic theories of change. For case-specific challenging behavior, the Bayesian models indicated lower stereotyped behavior during the intervention phase for Participants 1, 2, and 3. For Participant 5, aggressive/destructive and stereotyped behavior showed only a small descriptive change in the expected direction, without a model-based indication of phase-related change. Positive emotional functioning showed no consistent model-based phase-related change across participants. Nocturnal PRV also showed no consistent model-based phase-related change; in Participant 5, it decreased during the intervention phase.

DISCUSSION

This study examined the development and preliminary evaluation of person- and context-specific

interventions targeting selected recurring daily stressors in residential care. The first research question concerned how such interventions were formulated and implemented. Across all five cases, intervention teams identified a recurring daily stressor, formulated an idiographic theory of change, and used this formulation to develop a case-specific intervention. The existing care teams implemented the interventions within everyday care, thereby modifying exposure to the selected recurring daily stressor. The second research question concerned the evidence for change after implementation. Change could be evaluated for four of the five participants. The clearest preliminary evidence concerned target behavior, for which three of these four participants showed an indication of change in the expected direction in the Bayesian analyses, supported by descriptive and visual patterns, with non-overlap analysis reaching significance only in Participant 1. Positive emotional functioning and nocturnal PRV did not change consistently. The contribution of this study is to show that recurring daily stressors, which are easily overlooked and hard to change because they are intertwined with everyday care, can be made explicit and modified at the level of the care context rather than the individual, with preliminary evidence that this can produce change.

Addressing the first research question, the structured case formulation procedure helped teams connect a selected, recurring daily stressor to a participant's challenging behavior and positive emotional functioning within the everyday care context [23-25]. For each case, the formulation specified how exposure could be modified along three dimensions, frequency, perceived impact, and control, for example, by making the stressor more predictable or less impactful [17, 22]. This grounded the intervention in the stress-theoretical idea that repeated exposure to daily stressors with insufficient recovery contributes to behavioral and emotional dysregulation [17, 19]. Reducing the frequency or perceived impact of these stressors, or increasing the person’s control, may therefore limit repeated activation of the stress system and support more complete recovery, thereby limiting the accumulation of allostatic load and supporting behavioral regulation [17, 20].

Addressing the second research question, target behavior showed the most consistent indications of change among the three outcomes. This is consistent with target behavior being the most proximal and directly observable outcome: it was defined in relation to the selected recurring daily stressor, whereas positive emotional functioning represented a broader proximal outcome and nocturnal PRV a distal physiological indicator [44, 54]. The interventions modified the situations in which these behaviors repeatedly occurred. The indications of change were concentrated in cases targeting stereotyped behavior, whereas cases involving aggressive or destructive behavior did not show a comparable pattern: one could not be evaluated due to delayed implementation, and in the other, the intervention phase coincided with serious personal and relational events. Previous evaluations of individualized behavioral interventions, including positive behavior support, have also found reductions in challenging behavior, although effects have varied across participants, studies, and implementation contexts [11, 55, 56]. The present approach shared this person- and context-specific orientation but differed in making exposure to a selected recurring daily stressor the explicit intervention target.

Positive emotional functioning was included because stressor-focused interventions may affect more than challenging behavior [30]. In stress theory, affective responses are part of the stress response, and low positive affect after daily stressors may indicate poor recovery [17]. The absence of a clear model-based phase-related change may reflect the measure's limited sensitivity in this context. Compared with observable incidents of challenging behavior, proxy ratings of enjoyment, engagement, and responsiveness are harder to interpret, particularly when communication is limited, and ratings depend on subtle behavioral cues [57-59]. In addition, positive emotional functioning scores were in some cases already relatively high at baseline, leaving limited room to detect further improvement.

Nocturnal PRV was included as a distal physiological indicator of recovery and regulatory flexibility following stress activation [17, 32, 33]. Nocturnal PRV showed no clear phase-related improvement and decreased in Participant 5, whose intervention phase coincided with serious personal and relational events. Nocturnal HRV is responsive to stress [36], but as a distal indicator, it may require larger or more sustained reductions in exposure to recurring daily stressors than this study achieved [31]. Measurement may also have played a part. Nocturnal PRV varies across sleep stages and circadian phase, so the single nightly value may have obscured changes occurring during specific parts of the night [60].

Methodological Considerations

The findings should be interpreted in light of several methodological limitations. Case selection and implementation context are the first of these. Participants were referred by behavioral specialists based on suitability for the study, consent procedures, and the care team's willingness to engage in the intervention and data collection. This may have introduced selection bias towards cases and teams for which participation was considered clinically and practically feasible. The cases varied in residential setting, staffing intensity, and type of recurring daily stressor; this variation fits the idiographic, case-specific aim of the study, but the cases were not selected to represent the full range of residential care contexts.

Strengths include the structured development of person- and context-specific interventions, repeated measurement, and implementation by existing care teams in everyday residential care. Conducting the study in routine care increased its ecological relevance, although it also reduced experimental control [37].

A limitation is that the researcher took part in developing the case formulations. Although the case-formulation procedure helped teams develop interventions from a structured idiographic analysis of recurring daily stressors, behavior, emotional functioning, and care context, formulation and evaluation were not fully independent.

The contribution of the selected stressor was difficult to separate from other stressors, contextual events, staff responses, and team processes, because the case formulations linked multiple interacting factors. Discussing the stressors with teams may also have raised staff awareness, so that some change may have begun before or alongside the formal intervention phase, consistent with a Hawthorne effect [61].

The AB single-case design allowed repeated observation of level and trend before and after implementation, with intervention onset following completion of case formulation and local implementation preparations. Compared with multiple-baseline or randomized phase-change designs, however, it provided less experimental control. Because intervention onset was neither staggered nor randomized, observed changes could not be confidently separated from pre-existing trends, concurrent contextual events, or other time-related influences. The findings therefore provide preliminary, case-specific indications rather than causal evidence of intervention effects [37-39]. The strength of the case-specific analyses also depended on the number and distribution of observations within phases, which varied across cases and were particularly limited for Participant 4, who had only 18 intervention-phase days.

The Bayesian analyses estimated the direction, size, and uncertainty of change within cases, supporting interpretation as graded case-specific evidence rather than binary evidence of effect or no effect [52, 53]. These estimates should be read with several caveats. First, the autoregressive structure was not modeled, which, in serially dependent single-case data, can narrow credible intervals. However, assumption checks suggested that the autoregressive structure was weak or negligible across cases; we therefore expect minimal effect on the credible intervals from omitting these terms. Second, several intervals were estimated within each case, so an individual interval excluding zero need not be meaningful. Third, target behavior consisted of counts per shift, resulting in a zero-inflated distribution, in which the Gaussian model was only an approximation.

Several measurement considerations should also be noted. Daily staff ratings were a practical strength, enabling repeated measurement throughout the study period. At the same time, ratings may have been affected by time pressure and by variation in how rating anchors were interpreted. Because the same staff rated both target behavior and positive emotional functioning, implemented the interventions, and were aware of the study phase, part of the observed pattern in these outcomes may reflect observer or expectancy bias rather than change. Missing questionnaire data reflected the realities of data collection in residential care and, because these observations were unlikely to be missing completely at random, reduced the precision of case-level estimates [48]. The physiological measure adds further caveats. Wearable-derived nocturnal PRV, used as a proxy for HRV, enabled repeated physiological monitoring but depended on device-specific preprocessing; because PRV and HRV are not fully interchangeable and wrist-based PPG is sensitive to movement and signal quality, these values should be interpreted cautiously [47]. PRV estimates were also less reliable when many nights were missing; in Participant 2, where up to 60% of nights lacked valid estimates, the PRV results should be interpreted with particular caution. Physiological missingness may itself have been non-random, particularly on nights with greater restlessness.

IMPLICATIONS AND FUTURE RESEARCH

The stressor-focused approach complements existing assessment and intervention approaches for challenging behavior by examining how repeated exposure may accumulate across everyday situations and whether its frequency, perceived impact, or the person's control can be modified within routine care. For residential care teams, recurring daily stressors are concrete, modifiable features of daily care; adjusting them may help reduce persistent challenging behavior. A structured case formulation procedure can help behavioral specialists or psychologists, together with direct support workers, identify recurring patterns in daily care, consider how these may contribute to persistent challenging behavior, and decide whether the frequency or perceived impact of a recurring daily stressor can be reduced or the person's control increased. Agreed changes can then be incorporated into the daily support plan and reviewed with other relevant disciplines.

Future studies should strengthen the evaluation of stressor-focused interventions in several ways. Where interventions are sufficiently comparable, future replications across care organizations could use multiple-baseline designs with staggered introduction or randomized intervention onset to strengthen inferences about change. Implementation should be studied as part of the intervention itself: staff adherence, organizational conditions, and how changes are introduced, adapted, and maintained in routine care [62, 63]. Once feasibility and fidelity are established, studies could examine implementation burden, resource use, and cost consequences.

Future research could improve data collection by assigning explicit responsibility for questionnaire completion, use of the wearable device, and follow-up of missing observations. This may reduce avoidable missing data while keeping research monitoring separate from clinical responsibility for the participant's care. Longer intervention periods and post-intervention follow-up may help determine whether behavioral, emotional, and physiological changes are delayed or maintained. Studies could also examine whether targeting a single recurring daily stressor differs in effect from addressing several co-occurring stressors at once.

CONCLUSION

In conclusion, recurring daily stressors can be made explicit within individual cases and used to guide person- and context-specific intervention development in residential care. The structured case formulation procedure may help care teams translate recurring patterns associated with challenging behavior into concrete adjustments to everyday support. Across the five cases, observed changes were clearest for target behavior.

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GREEK SYMBOLS AND SPECIAL CHARACTERS

β = regression coefficient in the Bayesian regression models.

τ_u = Tau-U coefficient.

LIST OF ABBREVIATIONS

AB = baseline–intervention design

BPI-S = Behavior Problems Inventory - Short Form

CrI = credible interval

HRV = heart rate variability

IQR = interquartile range

PPG = photoplethysmography

PRV = pulse rate variability

RMSSD = root mean square of successive differences

VG = Dutch residential care profile

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHOR CONTRIBUTIONS

Conceptualization, M.A.H., L.W. and M.J.J.; methodology, M.A.H., E.J.C.S., A.P. and L.W.; investigation, M.A.H. and E.J.C.S.; formal analysis, M.A.H., E.J.C.S. and A.P.; data curation, M.A.H. and E.J.C.S.; visualization, M.A.H. and E.J.C.S.; writing—original draft preparation, M.A.H.; writing—review and editing, M.A.H., E.J.C.S., A.P., L.W., V.C.O.-P. and M.J.J.; supervision, L.W. and M.J.J.; project administration, M.A.H. All authors have read and approved the final manuscript.

HUMAN RIGHTS

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Review Committee of the Faculty of Social and Behavioural Sciences at Utrecht University (approval number 24-0308).

CONSENT TO PARTICIPATE AND FOR PUBLICATION

Consent for participation was obtained for all five participants. When participants were unable to provide consent themselves, consent was obtained from their legal representatives. Where possible, participation was also discussed with the participants themselves using accessible information.

DATA AVAILABILITY STATEMENT

The data are not publicly available due to ethical and contractual restrictions, as well as the small number of cases, which may allow indirect identification of participants. Fully anonymized or aggregated data, as well as the R scripts, may be made available from the corresponding author upon reasonable request.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors used ChatGPT (OpenAI) for language editing and readability. All content was reviewed and approved by the authors, who take full responsibility for the manuscript.

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