

**The Effects of a Pressure Vest on Task Engagement, Challenging Behavior, and a  
Physiological Measure of Stress for a Child with Intellectual Disability**

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## Abstract

We examined the effect of wearing a pressurized vest, a commonly use sensory support, with one student who had disabilities and for whom this sensory support was indicated. Using single-case reversal design logic (A-B-C-A), we measured effects on both observable behavior and a physiological measure of arousal, electrodermal activity (EDA). Behavioral results indicated that the interventionist's instructional practices affected the frequency of behaviors observed, but the pressure vest did not. EDA results were inconclusive but offered no significant indications of the pressurized vest affecting levels of arousal. We present the results of this study, its limitations, and a discussion of the use of these two measures in evaluating sensory-based therapies.

*Keywords.* Sensory supports, sensory therapy, challenging behavior, electrodermal activity (EDA), pressure vest

**The Effects of a Pressure Vest on Task Engagement, Challenging Behavior, and a Physiological Measure of Stress for a Child with Intellectual Disability**

Proponents describe sensory integration as a naturally occurring neurobiological process whereby the brain interprets sensory input received by the body (Hatch-Rasmussen, 2012; Watling & Dietz, 2007). Researchers and practitioners have theorized that, for many individuals with disabilities, when the brain does not integrate or organize sensory information appropriately, development, information processing, and behavior may be negatively impacted (Hatch-Rasmussen, 2012; Lang et al., 2012). For example, everyday occurrences such as loud noises and rapid motion are believed to be overwhelming to someone who has difficulty regulating sensory input and may result in a behavioral outburst.

To address concerns about sensory regulation, occupational therapy (OT) and sensory supports have often been recommended in an attempt to help individuals regulate sensory input and modulate arousal levels (Cermack & Henderson, 1989; Lang et al., 2012). Sensory supports often include procedures or activities such as wearing a weighted vest or blanket, swinging, or being brushed or rubbed with various tools (Lang et al., 2012). These supports are hypothesized to be useful for improving an individual's ability to process sensory stimuli because providing specific forms of sensory stimulation is believed to capitalize on the nervous system's ability to change (i.e., neuroplasticity) and improve the ability of the nervous system to process and integrate sensory input (Lang et al., 2012). If successful in producing these changes, it is purported that this then results in increased attention and adaptive behavior and fewer problem or stereotypic behaviors (Hodgetts, Magill-Evans, & Misiaszek, 2010; Lang et al., 2012; Reichow, Barton, Good, & Wolery, 2009). However, because these supports can be calming (e.g., brushing, massaging) and/or preferred (e.g., swinging, riding on a scooter board), observed

positive effects might be attributable to the child's opportunity to escape an unpreferred situation or engage in a pleasant or preferred activity instead of the mechanisms inferred by proponents of sensory supports. The former explanations emanate from a behavioral conceptualization of sensory challenges.

Researchers have examined the effects of various sensory supports on physiological measures, such as heart rate or cortisol levels, to explore whether they can produce both physiological and behavior changes. Hodgetts et al. (2010) measured the heart rate of participants when wearing a weighted vest and when wearing the same vest without weight to measure the physiological effect of the support using a single-case withdrawal design (A-B-C-B-C). They found that wearing a weighted vest did not reduce heart rate (i.e., produce a calming effect) in the four participants for whom heart rate was measured. For one participant, his heart rate actually increased while wearing the weighted vest, perhaps because the additional weight required greater energy to move. Additionally, they found that "the weighted vest did not functionally decrease motoric stereotyped behaviours (*sic*) but may have possibly decreased [one participant's] verbal stereotyped behavior" (p. 810).

Devlin et al. (2011) measured the level of cortisol in three of their participants' saliva across three conditions: (a) baseline, (b) sensory integration therapy, and (c) behavioral intervention. Increased cortisol production has been associated with psychological stress. Employing a single-case alternating treatments design with an initial baseline phase and a final best-treatment phase, Devlin et al. found little difference between cortisol levels across the three conditions. Additionally, they found that the behavioral intervention was more effective in reducing the frequency of challenging behavior than was the sensory-based treatment.

Electrodermal activity (EDA) is an emerging physiological measure that also has been associated with changes in levels of arousal and stress. EDA, also referred to as galvanic skin response, is a commonly used physiological measure associated with changes in levels of sympathetic arousal. It reflects electrical skin conductance produced by changes in sweat production. Because sweat glands are controlled by the sympathetic nervous system, researchers have suggested that changes in EDA may reflect changes in arousal (Andreassi, 2000; Boucsein, 1992). EDA can be measured through a small, watch-like sensor worn on the ankle or wrist that recorded movement (accelerometer), temperature (thermometer), and EDA levels.

One commonly used sensory support is the application of pressure to provide a proprioceptive sense, often produced by wearing a pressure vest (Reichow et al., 2009). Temple Grandin, a renowned author with autism, reported that the deep pressure she received from the “squeeze machine,” that she created in her youth, enabled her to interact more adaptively with her environment (Grandin, 1992). To simulate the input provided by Grandin’s squeeze machine, a pressure vest is a soft garment that is intended to calm the person wearing it, give a proprioceptive sense of a hug, and help with regulation of sensory input and behavior consistent with theories of the effects of experiencing deep pressure (Reichow et al., 2009; Zissermann, 1991; see Krauss, 1987 for a history of deep pressure). In a study examining the effect of wearing a pressure vest on the engagement and problem behavior of a child with developmental disabilities, Reichow et al. (2009) found no systematic changes in engagement and a “greater percentage of intervals of problem behaviors during the pressure vest condition than the initial baseline condition” (p. 1220).

OT and sensory support techniques, including the application of pressure vests, are common practices in educational and therapeutic settings, yet we lack sufficient credible

scientific studies demonstrating functional relations between the application of these techniques and positive changes in the arousal level and behavior of the individuals receiving the intervention (Barton & Reichow, 2012; Hodgetts et al., 2010; Lang et al., 2012; Reichow et al., 2009; see May-Benson & Koomar, 2010 for a review). In fact, of the limited number of empirical studies aimed at demonstrating causal relations between sensory supports and improved behavior and arousal, many have found no effect or a negative effect (Fedewa, Davis, & Ahn, 2015; Lang et al., 2012; Zimmer & Desch, 2012; see also Devlin, Healy, Leader, & Hughes, 2011; Reichow et al., 2009; Watling & Dietz, 2007). Others have found positive effects on some behaviors and no or negative effects on others (e.g., Bagatell, Mirigliani, Patterson, Reyes, & Test, 2010; Lin, Lee, Chang, & Hong, 2014). Still others have identified positive effects but employed research methods that preclude causal claims (e.g., pre-/post-assessment of a single participant in Schaff, Hunt, & Benevides, 2012) or relied primarily on parent- or teacher-completed rating scales, rather than measures of observed behavior, to evaluate the effects (e.g., Pfeiffer, Koenig, Kinnealey, Sheppard, & Henderson, 2011). This lack of empirical evidence has been noted by the American Academy of Pediatrics and pediatricians are advised to “communicate with families about the limited data on the use of sensory-based therapies for childhood developmental and behavioral problems” (Zimmer & Desch, 2012, p. 1188).

### **Purpose**

With the lack of empirical evidence for sensory supports as context, we proposed to replicate and extend prior studies that have investigated sensory support interventions. Specifically, we examined the effect of a pressure vest on behavioral and physiological measures during school activities for a child with an intellectual disability. We were seeking to discover:

1. if wearing a pressurized vest would produce predictable, measureable changes in the level of engagement with a task or the level of challenging behavior,
2. if wearing a pressurized vest would produce predictable, measurable changes in skin conductance levels (EDA), and
3. if changes in EDA corresponded with observable changes in the level of engagement with a task and/or the level of challenging behavior.

We replicated prior studies by using single-case research methodology to examine the efficacy of a pressure vest. We added EDA as a dependent variable measure to expand the measures typically examined in recent SI studies and create an opportunity to assess the relation between behavioral and physiological variables, both hypothesized to be affected by sensory supports.

In addition to addressing the three research questions, we believe a unique feature of this investigation was the constitution of the research group. We intentionally recruited investigators from diverse, but relevant, academic domains whose initial perspectives differed in terms of the efficacy of sensory supports; most believed they were effective, others were skeptical. Included in the research group were a practicing OT and professors and/or doctoral students in computer science, speech and hearing science, neuroscience, and special education. We made an effort to ensure that the sensory support procedure was appropriate for the participating child and was implemented with fidelity and in accord with current best practice. The practicing OT conducted a sensory assessment and then consulted with the investigators about the intervention procedure.

### **Methods**

We systematically examined the effect of wearing a pressurized vest with one student, Damien, who had disabilities and for whom this sensory support was indicated using single-case reversal design logic (A-B-C-A).

## **Participant**

Damien was a 9-year-old boy recruited by the participating OT from her caseload in the local schools. He had a primary diagnosis of intellectual disability and a secondary diagnosis of physical impairment. He had a seizure disorder and received school-based occupational therapy services. His parent provided informed consent for his participation in this study. Damien did not speak but used gestures, facial expressions, and vocalizations to communicate with others. These idiosyncratic communication strategies often led to communication breakdowns during which he would yell, bang on the table with his hands or objects, or move away from others. Damien could walk, but he needed an adult in close proximity at all times to break his fall if a seizure occurred. School staff reported that he experienced complex partial, absence, and tonic clonic seizures, but that he was on medication that made seizure activity infrequent. He had minimal to no deficits in fine motor skills, but had not yet learned to use everyday objects for their intended purpose (e.g., use a pencil to mark on paper) or classify objects by attribute (e.g., sort by color, shape, matching items, etc.).

Damien routinely engaged in behaviors that his special education team considered to be sensory-based and were (a) disruptive to others, such as making vowel sounds for prolonged durations (e.g., “Oooooo.”); (b) potentially harmful to himself or others, such as throwing items; or (c) undesirable or unacceptable to his classroom teacher, such as making vocalizations in a low, growling voice. We use the term “challenging behavior” throughout to refer to behaviors perceived as such by the members of his educational team. As a result of these behaviors, Damien was considered a candidate for sensory supports. To determine which sensory supports might be best suited for him, his occupational therapist (OT) recommended that Damien’s parent and teacher complete the Short Sensory Profile (Dunn, 1999). According to the OT, the results

of the profile indicated that a pressure vest would be an appropriate intervention. (This was an intervention the OT used often.)

### **Setting and Materials**

The study was conducted in a separate room in the school to minimize the influence of other sensory inputs, such as noise or visual stimulation of others' movements, that occurred in his classroom and to allow for videotaping sessions. In this experimental room, Damien and the interventionist, a member of the research team and a former teacher, sat at a small table and worked on three of his existing Individualized Education Program (IEP) goals that addressed (a) counting, (b) fine motor development for using a fork or putting items into containers, and (c) sorting items by attribute. First, Damien was given a choice between two types of toys. After his selection, he was given a group of those toys to count and put into a container. Then, he was offered a choice of two fruits. The fruit he chose was cut into bite-sized pieces and placed on a plate with a lip. He used an adapted fork to eat this snack. Finally, Damien was asked to clean up the table by sorting toys into one container and dishes into another. A video camera and computer were located in the experimental room to record the sessions and to assess: (a) procedural fidelity, (b) Damien's behavior, and (c) the physiological data (described in the next section). During all sessions, Damien wore a pressure vest and an Affectiva q-sensor.

**Pressure vest.** During all sessions, Damien wore a neoprene pressure vest. The vest was fitted by Damien's OT, who was a member of the research team. The OT fitted the vest to two different settings: (a) without pressure and (b) with pressure. Each setting was marked on the vest by drawing a line in permanent marker to indicate where each Velcro closure on the vest should be placed.

**Q-sensor.** The q-sensor, produced by Affectiva, Inc., was the size of a large wrist watch. It was placed on Damien's right ankle with a soft band in his classroom 10 minutes prior to each session to allow time for the signal to stabilize (Hernandez, Riobo, Rozga, Abowd, & Picard, 2014). He continued to wear the sensor for approximately 10 minutes after the session had ended and he had returned to his classroom. The q-sensor recorded the EDA, temperature, and acceleration (i.e., movement) data. Following the session, the research team members synced the q-sensor with the Q Sensor Software (1.07.19). Precise details of how the q-sensor was employed (e.g., placement, stability, desensitizing) are available from the lead author by request.

### **Measurement**

These sessions with Damien lasted between 8-16 minutes. We collected data on three dependent variables, including two behavioral variables (i.e., engaged/on-task behavior, challenging behavior) and one physiological variable (i.e., EDA). The three dependent variables were assessed in the same manner throughout all phases of the study.

**Behavioral measures.** We recorded two behavioral variables using the video recordings of each session: (a) engaged, on-task behavior and (b) challenging behavior. Damien's engaged and on-task behavior during the session was defined as manipulating materials that were appropriate for the current task or looking at currently relevant referents (i.e., materials, teacher). His challenging and/or potentially sensory-based behaviors were based on his educational teams' perceptions and defined as verbal outbursts, tapping/banging on the table, throwing items, flapping his arms or hands, rocking, or sliding down in the chair. (Other less-disruptive behaviors his teachers thought to be self-stimulatory or self-reinforcing, such as tapping chin with knuckles or rubbing his head, were excluded from the definition.) These behaviors were measured using momentary-time sampling (Kennedy, 2005). Using BEDA, a software tool

designed by a computer science member of the research team (Kim, Snodgrass, Pietrowicz, Karahalios, & Halle, 2013), the video was segmented into 10-second intervals. The interventionist viewed the last 1-second of each 10-second interval to determine if either or both of the two behavioral variables had occurred and then recorded on a data sheet. The number of intervals in which the behavior occurred was divided by the total number of intervals in the session and multiplied by 100 to determine the percent of intervals in which each behavior occurred.

***Interobserver agreement for behavioral measures.*** An undergraduate student in Speech and Hearing Sciences who was trained in coding procedures conducted an independent assessment of behavioral coding. Each week of the study and totaling at least 40% of sessions in each phase, one session was selected at random. This second rater watched the video of the selected session using the same software and behavioral definitions and coded the occurrence of engaged and on-task behavior and challenging behavior.

A third member of the research team independently compared the primary and secondary raters' coding and calculated interobserver agreement by scoring as agreements those intervals in which both raters coded the behaviors the same way (either as having occurred or not). Agreements were summed and then divided by agreements + disagreements and multiplied by 100. The results are summarized in Table 1.

---- Insert Table 1 about here. ----

***Physiological measure.*** We also recorded one physiological dependent variable, Damien's EDA, measured by the sensor he wore on his right ankle. There are two components in EDA: skin conductance level (SCL) and skin conductance response (SCR) (Benedek & Kaernbach 2010; Boucsein, 1993; 2012; Dawson et al., 2000). SCL is an absolute level of skin

conductance (see gray area in Figure 1) and SCR represents momentary changes in skin conductance (see dark grey line in Figure 1). SCL is typically interpreted to be associated with general states of arousal and is measured by averaging the level recorded across a session (Dawson et al., 2000). For example, SCL average is generally low during sleep and high in activated states, such as rage or mental work (Woodworth & Schloberg, 1954). Conversely, SCR is an indicator of temporary changes of arousal influenced by the presentation of a novel, unexpected, or aversive stimulus (Dawson et al., 2000). *SCR average* and *average number of peaks per minute* are commonly used to measure an individual's response to a specific stimuli (Dawson et al., 2000; 1988, see also James & Barry, 1984; Kushki et al., 2013). Specifically, *SCR average* measures an average of an individual's level of short-term arousal amplitudes across a particular session, capturing the overall affect of stimuli within that session on the person's arousal. *SCR average number of peaks per minute* reflects the number of times the SCR spikes (i.e., peaks) within each minute of that session and averages those frequencies, capturing the frequency with which stimuli within that session influenced arousal. The SCR peaks were counted if the spike's amplitude was larger than 0.05  $\mu S$ .

---- Insert Figure 1 about here. ----

We measured Damien's SCL average, SCR average, and SCR average number of peaks per minute for each session of the study. These measures are consistent with prior literature that reported EDA data (Boucsein, 1993; 2012; Dawson, 2000, Benedek & Kaernbach, 2010; James & Barry, 1984; Kylliäinen & Hietanen, 2006; Woodworth & Schloberg 1954).

### **Design**

We employed single-case reversal design logic (A-B-C-A) to evaluate the effect of the pressurized vest on the participant's behavior and EDA. We selected this design because the

most direct method of examining the impact of the intervention was to compare outcomes with and without pressure. If we did not observe a change in behavior when the pressurized vest was applied (i.e., did not demonstrate an effect), we could return to the unpressurized phase and then apply a different intervention (i.e., not the pressurized vest) to demonstrate that the target behaviors were amenable to another treatment. Our implementation of the design was shaped by the accumulating behavioral data and our decision-making with regard to the design is revealed in the paragraphs that follow. We based these decisions exclusively on the behavioral data; the EDA data were secondary and were not examined until the study concluded.

Damien wore the vest throughout every phase to control for the wearing of the vest; pressure was applied only during particular sessions (i.e., one phase). We hypothesized that Damien would engage in more challenging behavior and fewer on-task and engaged behaviors when he was asked to participate in instructional activities that were unpreferred and when the vest was not pressurized.

### **Procedures**

The intervention (i.e., instructional procedures, vest pressure) varied by phase, as described in the following paragraphs.

**A Phase: Structured Teaching/No Pressure.** At the beginning of the study, Damien's classroom teacher was on leave so a member of the research team, a former special education teacher who became the interventionist for this study, collaborated with Damien's educational team to create a systematic prompting and reinforcement instructional program to address three IEP goals. No existing consistent instructional program could be located. In this phase, Damien received this structured teaching and wore the vest, but without pressure.

**B Phase: Unstructured Teaching/No Pressure.** During the A Phase, Damien did not engage in the same high levels of challenging behavior that the classroom staff had reported was occurring in the classroom (the original reason for selecting this participant). In fact, his level of engaged behavior was high and gradually increasing. Because Damien's performance was entirely satisfactory, we had no reason to apply the pressure vest. In an effort to resolve this discrepancy, the interventionist observed instructional sessions in the classroom led by the paraprofessionals and substitute teacher to identify any differences that may have accounted for the unexpected findings. In addition to the sensory stimulation present in the environment (e.g., noise, movement of others), the classroom staff did not apply systematic instructional procedures to teach Damien skills. For example, systematic prompting consists of changing (often fading) the amount of support required to produce the desired response. Instead, the staff members were using a verbal prompt repeatedly, regardless of its success at producing the target response. This is trial-and-error instruction such that if Damien responded correctly, he received contingent praise or a tangible item; if he responded incorrectly, the same ineffective prompt was repeated.

In the B Phase, we endeavored to simulate the instructional procedures that were used in the classroom. The interventionist began trials with a direction, and then, if Damien did not respond, gave repeated verbal prompts that mirrored classroom practices in an attempt to elicit a correct response. She provided contingent consequences based on his response (i.e., praise, a tangible, or repeated the prompt). Thus in Phase B, the interventionist delivered "unstructured" teaching to determine its impact on Damien's behavior and EDA. Damien continued to wear the vest throughout this phase, but without pressure.

**C Phase: Unstructured Teaching/With Pressure.** When Damien received unstructured teaching without pressure in the B Phase, his challenging behavior became more variable and

then increased substantially as his on-task and engaged behavior trended in the opposite direction. The C Phase provided the first opportunity to ask the key question about the effects of a pressure vest. In this phase, the unstructured teaching continued and the vest was fitted to meet the pressurized setting.

**A Phase: Structured Teaching/No Pressure.** We returned to the original A Phase conditions during which Damien received structured teaching and wore the vest with no pressure. This phase was implemented to determine if a reversal would ensue.

### **Procedural Fidelity**

The interventionist recorded the steps she followed on an instructional checklist form during every session she conducted. There were 37 steps possible in the structured teaching sessions and 28 steps possible in the unstructured teaching sessions (a list of these instructional steps is available from the lead author). The same undergraduate student, who was trained in coding procedures and provided an independent assessment of recording the dependent variables, checked the procedural fidelity on the same randomly selected sessions. She watched the video and, using the same checklist of the instructional procedures, recorded each step that was completed correctly. The number of steps on which the two recorders agreed that the step was completed correctly or incorrectly was divided by the total number of steps and multiplied by 100 to yield a fidelity score (see Table 1 for a summary of the results).

### **Generalization, Maintenance, and Social Validity**

Often in a study such as this, investigators will address these hallmarks of rigorous applied research. However, when the results reveal that the intervention being examined fail to produce an effect on the dependent measures, these additional features become irrelevant.

## **Results**

## Behavioral Results

The behavioral results are presented in Figure 2 and Table 2. In Phase A (structured teaching with unpressurized vest), Damien's data path assumed a gradually increasing trend and maintained a high rate of engaged and on-task behavior throughout the phase. He was engaged and on-task for an average of 82.3% of the intervals (see Table 2). During this phase, he also maintained a somewhat stable and low rate of challenging behavior; he averaged 12.2% of the intervals. These rates contradicted the reports by the educational team about Damien's behavior in the classroom. The instructional procedures were modified for Phase B in an effort to simulate or approximate those existing in the classroom.

----- Insert Figure 2 about here. -----

----- Insert Table 2 about here. -----

By the end of the B Phase (unstructured teaching with unpressurized vest), a notable decrease in the level of Damien's engaged and on-task behavior was observed. On the final day of Phase A, he was engaged and on-task for 88.5% of the intervals; on the first day of Phase B, he was engaged and on-task for 27.3% of the intervals. His rate of engaged and on-task behavior was variable until the fifth session in Phase B and stabilized below 10% of the intervals during the final three days of this phase. No data point in Phase B overlapped with those in Phase A. Damien's rate of challenging behavior during the first four sessions of Phase B was somewhat variable and remained similar in level to that in Phase A. However, a clear change in level was evident on the fifth day and remained stable (exceeding 80%) for the following two sessions. With rates of challenging behavior consistently above 80%, we now could pose the question about the effect of a pressurized vest on the defined challenging behavior, hypothesized to be sensory in origin.

In Phase C (unstructured teaching with pressurized vest), Damien's rate of engaged and on-task behavior remained low (average of 7.74% of the intervals) and his rate of challenging behavior remained high (average of 88.6% of the intervals). The level of behavior during the last three data points in Phase B was indistinguishable from the five data points comprising Phase C. These data led us to the conclusion that, for Damien, the pressurized vest did not have a discernable effect on the target behaviors. With the stable and high rates of challenging behavior (and low rates of engaged and on-task behavior) established in Phase C, we returned to the conditions of Phase A to attempt a reversal and a replication.

Coincidental with the introduction of Phase A (structured teaching with unpressurized vest), Damien immediately returned to high rates of engaged and on-task behavior (average of 88.3% of the intervals) and low rates of challenging behavior (average of 8.1% of the intervals). The change in the rates of both behaviors was dramatic and immediate.

### **Physiological Results**

The results of our EDA analysis are presented in Table 3. Two sessions (March 12 and May 8) of EDA data were discarded because the sessions' EDA signals were very low (below 0.6  $\mu$ S) during the entire session, possibly associated with a loss of electrode contact with the skin due to physical activity. SCR average and SCR average number of peaks were variable, so only means and standard deviations for each phase are presented in Table 3. We conducted the Mann–Whitney U test to determine if changes in these measures differed significantly from the preceding study phase. Because significant changes between study phases were only observed for SCL average, we present the graph of the SCL average results in Figure 3. Notably, Damien had seizures before or during four sessions in the first A Phase, five sessions in the B Phase, and one session in the C Phase, underlined in Figure 3.

----- Insert Figures 3 about here. -----

----- Insert Tables 3 about here. -----

In the first A Phase (structured teaching with unpressurized vest), Damien maintained a low level on the SCL measure; he averaged 3.1  $\mu\text{S}$  (see Table 3 and Figure 3). In the B Phase in which he received unstructured teaching with an unpressurized vest, his SCL average increased and as did his challenging behaviors (see Figure 2); all SCL averages were above 5.5  $\mu\text{S}$  except for the third session that had 2.7  $\mu\text{S}$  (see Figure 3). This increase was significant at  $p < 0.01$  when compared to the SCL average in Phase A, as measured by the Mann–Whitney U test. In Phase C in which the vest was pressurized while receiving unstructured teaching, Damien's SCL decreased to 4.4  $\mu\text{S}$  (see Table 3); all SCL average values were below 4.5  $\mu\text{S}$  except for the third session that had 5.9  $\mu\text{S}$  SCL average. When Damien returned to the conditions of the A Phase (structured teaching with unpressurized vest), his SCL average dropped to 2.1  $\mu\text{S}$  on the first day of Phase A-2 (see Figure 3) and the mean of SCL averages across sessions returned to levels similar to the original Phase A (see Table 3).

When we examined the measures of SCR, no statistically significant changes between study phases were found. Damien maintained a low level of SCR *average* and *average number of peaks* in Phase A and both measures increased in Phase B relative to those in Phase A, consistent with the pattern observed in SCL; when Damien returned to the A Phase, his mean SCR *average* returned to the level observed in the original Phase A and the mean SCR *average number of peaks* returned to a level lower than that observed in the original Phase A (see Table 3). Unlike patterns in SCL, in Phase C in which the pressure vest was applied with unstructured teaching, both SCR measures increased compared to those in Phase B (see Table 3). This

increases in SCR *average* ( $p = 0.8$ ) and SCR *average number of peaks* ( $p = 0.41$ ) were not statistically significant as measured by Mann–Whitney U test.

### **Discussion**

Our preliminary conclusion based on Damien's behavior data is that the pressurized vest had no discernable effect on either the challenging or engaged/on-task behaviors that we measured during academic tasks in the experimental setting for this student. Instead, the interventionist's instructional practices appeared to be the primary factor impacting Damien's behavior (see Figure 2). When she introduced systematic instructional procedures within the work routine, he remained engaged and on task for approximately 85% of the intervals. When the interventionist switched to a single verbal prompt and less structured procedures that were similar to the way instruction was delivered in the classroom, Damien engaged in high rates of challenging behavior (7 of the final 8 sessions exceeded 80% of the intervals, regardless of whether the vest was pressurized or not), and he was on-task and engaged for 20% or fewer of the intervals during the same eight sessions. Pressurizing the vest in the unstructured teaching phase did not produce a change in behavior.

Our preliminary conclusion based on Damien's EDA data is that the pressurized vest had variable and inconclusive effects on his skin conductance and that any effect of the pressurized vest was not a significantly influential on his level of arousal, as measured by EDA. Because the pressurized vest was purported to reduce arousal levels, we hypothesized that wearing the pressurized vest would produce a reduction in the levels of SCL and/or SCR, but our data did not support this hypothesis. Although Damien's mean SCL average decreased while wearing the pressurized vest (Phase C) in keeping with the theorized effect of the vest, this change was not significant and his mean SCL average continued to decrease when the pressure was removed.

Damien's SCR average and SCR average number of peaks (measures of immediate changes in arousal and frequency of short-term arousal respectively) slightly increased when wearing the pressurized vest, a trend against the theorized effect, but these changes were also not significant. The only demonstration of a significant change in EDA that corresponded to a change in phase was that Damien's mean SCL average during the unstructured teaching phase (Phase B) was significantly higher ( $p < 0.01$ ) than the structured teaching phase (both Phase As), phases in which the vest was worn without pressure. However, he had seizures before or during five of the seven total sessions in Phase B (underlined in Figure 3). Because seizure activity may increase the level of SCL and SCR of EDA (Poh et al., 2012), these seizures may have influenced Damien's EDA levels. Given this, we cannot claim that changing from structured to unstructured teaching caused this significant increase.

When we compared the results of the behavioral and EDA data, the SCL average corresponded with changes in the behavioral data in all phases except Phase C where the former decreased (lower EDA levels) and the latter remained stable (challenging behavior remained high and engaged/on task remained low). These results are ambiguous or equivocal. We cannot clearly conclude a direct relation between these two data sources and any conclusion about this relationship must await future investigation. The contribution of this study is the inclusion of a physiologic measure to accompany the more typical behavioral measures employed in social science research. By supplementing behavioral variables with physiologic measures, we broaden the scope of the examination of potential impacts of the sensory support.

### **Limitations**

Conclusions emanating from this study are limited because it reflects our experience with a single student and a single interventionist. In addition, that interventionist was a researcher and

not a member of Damien's IEP team and we did not measure Damien's behavior when he was not wearing a vest. Given these limitations, generalizing these findings to other children and interventionists must be done with extreme caution and attention to the similarities and differences between the conditions we describe here, especially the participant and the interventionist, and the conditions existing in any new situation of interest. In addition, our findings related to EDA are limited because the data are equivocal and because few guidelines exist for interpreting if or how seizure activity affects skin conductance and for interpreting if changes in EDA are associated with positive (e.g., higher EDA is reflective of excitement, engagement) or negative (e.g., higher EDA is reflective of stress, anxiety, challenging behavior) changes in arousal.

### **Conclusion**

In our examination of the effect of sensory support, a pressure vest, on the behavior and arousal (measured by EDA) of a single child, we found no conclusive indication that the pressure vest affected the child's challenging or engaged/on-task behavior or his level of arousal as measured by EDA during academic tasks. Instead, the extent to which the interventionist applied structured teaching procedures appeared to be the primary factor impacting this child's behavior.

We included a novel measure of arousal, EDA (skin conductance), and demonstrate how we used this measure in examining the efficacy of sensory supports for one child. Our application of this measure may have been limited by the presence of seizure activity in our participant. Researchers who employ this measure in the future should attend to and account for seizure disorders and use caution when interpreting results in such instances. Further research is needed to develop guidelines for interpreting physiological measures of arousal, such as EDA, permitting a distinction between arousal caused by excitement or enjoyment and arousal caused

by fear, anxiety, or anger that may assume a similar pattern in the EDA data. We hypothesize that aligning EDA with observational behavior data to identify what the participant is doing when changes in EDA occur might facilitate such distinctions. Linkage between these two data sources might contribute to the interpretation of EDA findings and/or might help identify key behaviors that should be included in behavioral recording.

This study contributes additional support to the American Academy of Pediatrics' caution for using sensory-based therapies in children with developmental or behavior disabilities (Zimmer & Desch, 2012) and reinforces the call for generating data that shed light on (a) the efficacy of sensory-based therapies and (b) the conditions under which such therapies are effective. However, as future researchers attempt to examine the efficacy of sensory supports and their perceived benefits for children with disabilities, we offer an example of and suggestions for including a physiological measure (EDA) to broaden the exploration of the potential impact of these supports.

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Table 1

*Interobserver agreement data*

Phase	Sessions Calculated	IOA: Engaged, on-task behavior	IOA: Challenging behavior	IOA: Procedural Fidelity
Phase A – Structured/No Pressure	45.5% of sessions (5/11 sessions)	88.0% (344/391 intervals)	91.6% (358/391 intervals)	96% (180/185 steps)
Phase B – Unstructured/No Pressure	42.9% of sessions (3/7 sessions)	94.0% (252/268 intervals)	98.1% (263/268 intervals)	95% (108/114 steps)
Phase C – Unstructured/With Pressure	60.0% of sessions (3/5 sessions)	96.6% (255/264 intervals)	98.9% (261/264 intervals)	100% (114/114 steps)
Phase A – Structured/No Pressure	50.0% of sessions (2/4 sessions)	86.0% (111/129 intervals)	94.6% (122/129 intervals)	93.2% (69/74 steps)

Table 2

*Mean percentage of occurrence of target behaviors by phase*

Study Phase	Mean % of engaged, on-task behavior	Mean % of challenging behavior
Phase A – Structured/No Pressure	82.6% (685/829 intervals)	11.9% (99/829 intervals)
Phase B – Unstructured/No Pressure	26.1% (163/625 intervals)	48.3% (302/625 intervals)
Phase C – Unstructured/With Pressure	7.6% (34/446 intervals)	88.8% (396/446 intervals)
Phase A – Structure/No Pressure	87.7% (222/253 intervals)	8.3% (21/253 intervals)

Table 3

*Mean of EDA measures by phase*

Study Phase	Mean of SCL average in $\mu\text{S}$ (Standard deviation)	Mean of SCR average in $\mu\text{S}$ (Standard deviation)	Mean of SCR average number of peaks per min (Standard deviation)
Phase A – Structured/No Pressure	3.1 (1.4)	0.09 (0.05)	0.28 (0.2)
Phase B – Unstructured/No Pressure	6.1 * (1.8)	0.16 (0.1)	0.37 (0.2)
Phase C – Unstructured/With Pressure	4.4 (1.0)	0.20 (0.2)	0.45 (0.2)
Phase A – Structure/No Pressure	3.4 (1.2)	0.08 (0.04)	0.09 (0.09)

*Note.* \* denotes significant change from previous phase at  $p < 0.01$

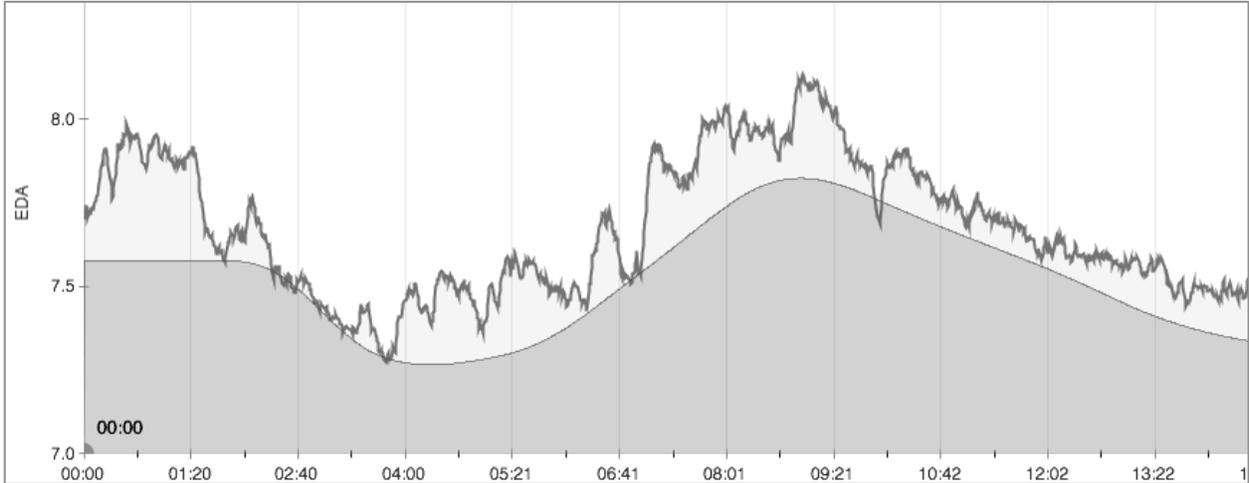


Figure 1. Skin conductance level (light gray area) and skin conductance response (dark grey area) components of EDA data.

**Damien's Behavior During Instructional Sessions**

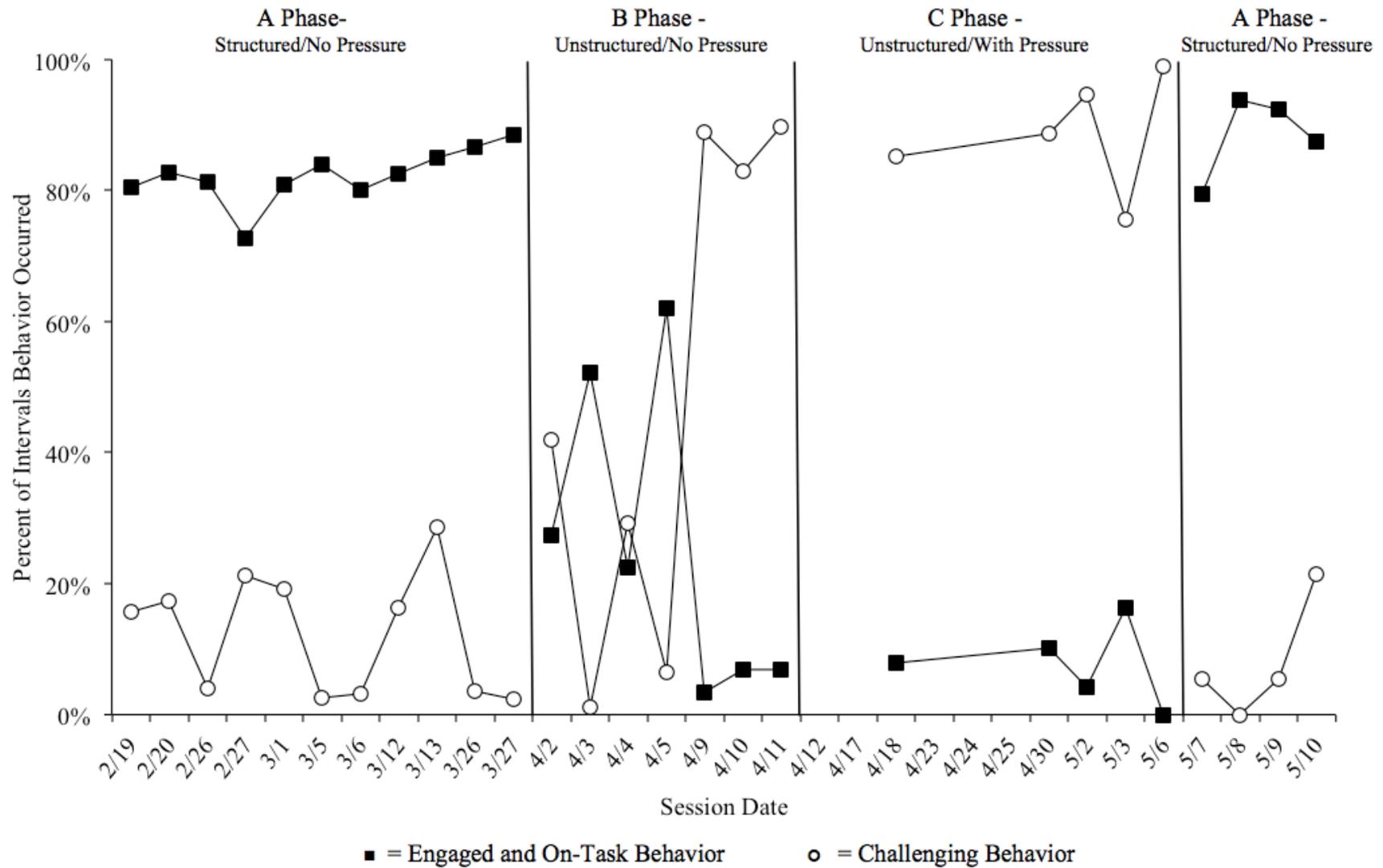


Figure 2. Graph of Damien's behavior during instructional sessions.

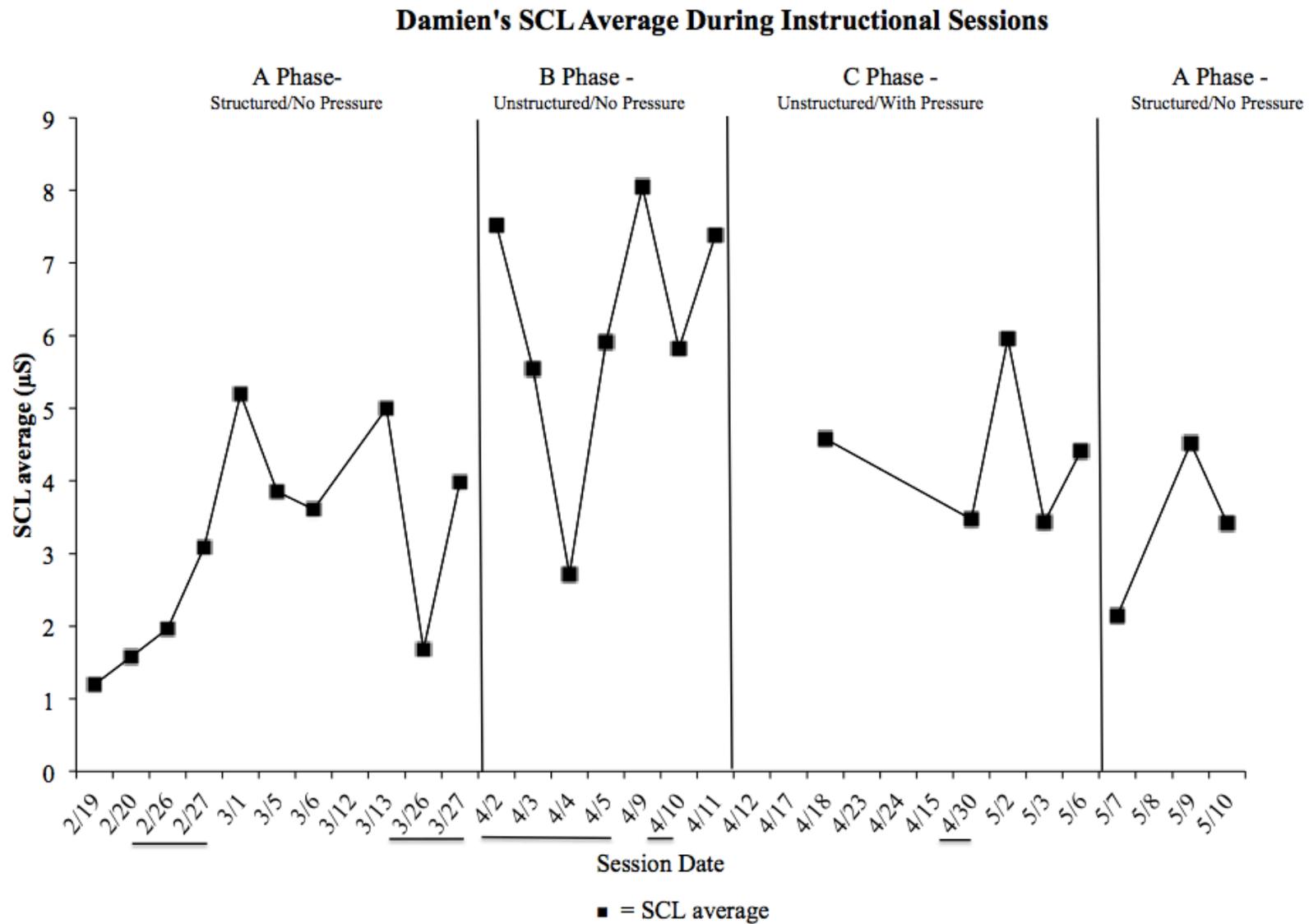


Figure 3. Graph of Damien's SCL average during instructional sessions. The underlined sessions are when Damien experienced seizure activity before or during the session.