The Effects of Gum Chewing on Classroom Performance in Children with ADHD:
A Pilot Study

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Abstract

A four-week single subject (A-B) research design examined the effects of gum chewing on classroom performance in two 2nd grade boys with a diagnosis of ADHD. This study focused on three variables: on-task behaviors, task completion, and quality of work. Data, using visual analogue scales, on these three variables were collected during 12 writing periods. The researcher observed and documented the participants' on-task behaviors, and the teacher scored the participants' quality and amount of work completed on writing assignments. Visual analysis and 2-standard deviation band methods were used to compare the participants' performance when gum was not chewed to the participants' performance when gum was chewed. The findings are inconclusive due to multiple limitations of the study. However, emerging secondary findings suggest that the child's needs, environment, and task demands may be important components to take into account when implementing gum as a sensory-based intervention strategy. Future research on the use of gum chewing for children diagnosed with ADHD in classroom settings is needed.

Keywords: ADHD, classroom performance, gum chewing, sensory integration

Attention deficit hyperactivity disorder (ADHD) is the most pervasive neurobehavioral disorder, affecting approximately 6-9% of children and adolescents in the United States (Dopheide & Pliszka, 2009). According to the U.S. Department of Health and Human Services (HHS, 2008), children with a diagnosis of ADHD have challenges in paying attention, managing behavior, and regulating arousal level. These challenges can impact academics, social participation, and occupational functions. Of these, the primary concern for these children is the academic success. As reported in the U.S. Department of Education (ED, 2003), persons with a diagnosis of ADHD have lower overall grades, more failing grades, higher dropout rates, and lower rates of college graduates than persons without disabilities.

Children who have a diagnosis of ADHD may work with school-based occupational therapists: professionals who are skilled at providing interventions to promote a successful learning experience for children with disabilities (Case-Smith, 2010). By collaborating with the child's parents, the general teacher(s), and other members of the education team, occupational therapists can evaluate the child's values and needs, create school-related goals, and implement effective treatments (Bazuk & Case-Smith, 2010). Intervention plans are different for each child and cannot be determined without a thorough analysis of his or her needs.

Of the intervention approaches used for children diagnosed with ADHD, sensory integration (SI) treatment approach is most frequently used due to both the increasing evidence supporting the presence of SI dysfunction and the effectiveness of this approach (Chu, 2003; Mangeot et al., 2001). SI is a difficult concept to define operationally. Dr. A. Jean Ayres (2005), the original theorist of SI, defined it as an "organization of sensations for use" (p. 5). The SI theory states that in order for a person to respond purposefully to a situation, his or her brain needs to interpret the senses from the environment and be capable of selecting only the needed

senses for use (Ayres, 2005). In addition, the theory suggests that a disruption in the neurological processing of sensations can negatively affect how an individual interacts with the environment. This disruption may ultimately impact the person's development of the needed skills for learning and good social behavior (Ayres, 2005).

Occupational therapists use the SI treatment approach by exposing children to various sensory stimuli while in the context of play which will enhance a child's ability to process the stimuli efficiently (Emmons & Anderson, 2005). Examples of these sensory stimuli are the tactile, vestibular, and proprioceptive stimulus. The effectiveness of using various sensory-based strategies to treat sensory-based problems has been supported by research. For example, wearing a weighted vest, doing yoga exercises, using dynamic seating such as a Disc "O" Sit or therapy ball, or chewing on rubber tubing or gum are sensory-based strategies that have been reported to improve the attention span in classroom settings among children with a diagnosis of ADHD (Jensen & Kenny, 2005; Mulligan, 2001; Olson & Moulton, 2004; Pfeiffer, Henry, Miller, & Witherell, 2008; Sayers, 2008; Schilling, Washington, Billingsley, & Deitz, 2003). Of those sensory-based strategies, gum chewing has many properties related to SI, leading occupational therapists to hypothesize that it might produce a calming effect and help increase attention. As a result, gum chewing has gained increased interest among school-based occupational therapists over the years. However, occupational therapists are hesitant about using gum because there is scant empirical evidence supporting the use of gum in classrooms. Therefore, a research study to investigate the effectiveness of gum chewing on classroom performance and engagement in children diagnosed with ADHD is necessary to understand its usefulness in school settings.

Background and Significance

Attention deficit hyperactivity disorder (ADHD) and occupational therapy.

According to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (DSM-IV-TR), ADHD has three subtypes: predominantly hyperactive-impulsive, predominantly inattentive, and combined hyper-impulsive and inattentive (American Psychiatric Association [APA], 2000). For the purpose of this paper, the term ADHD refers to all three subtypes. While it is normal for young children to be inattentive, hyperactive, or impulsive at times, these behaviors are reported to be more exaggerated and occur more frequently in children with a diagnosis of ADHD (HHS, 2008). Children with a diagnosis of ADHD (a) are easily distracted, (b) have difficulty focusing on one thing, (c) become bored with a task after a few minutes, (d) struggle to follow instructions, (e) play/touch with anything in near sight, (f) have trouble sitting still, (g) fidget and squirm in their seats, and (h) are impatient (APA, 2000). In order to confirm the ADHD diagnosis, the symptoms must be present before the age of 7 years and occur in multiple settings, such as at home and school, over a period of 6 months (APA, 2000). Even though the symptoms of ADHD persist into adulthood, the symptoms are usually most severe in younger children (Dopheide & Pliszka, 2009; HHS, 2008).

Children with a diagnosis of ADHD often have difficulties engaging in school-related tasks and performing at grade-level standards due the impairments caused by the core symptoms of ADHD: hyperactivity, inattention, and impulsivity (ED, 2008; Junod, DuPaul, Jitendra, Volpe, & Cleary, 2006). Barry, Lyman, and Klinger (2002) indicated that the more severe the ADHD symptoms are, the more negative school performance may be affected. According to another study, children diagnosed with ADHD have lower levels of academic engagement than children who were typically developing (Junod et al., 2006). That same study also found the level of

academic difficulties, such as inability to attend or complete classroom tasks, seen in children with a diagnosis of ADHD is correlated to the frequency of off-task behaviors (Junod et al., 2006).

When children with a diagnosis of ADHD exhibit significant challenges that prevent them from being successful in school, they may be eligible for occupational therapy services. School-based occupational therapists help improve classroom engagement and performance level in children with disabilities. The process by which occupational therapy services are typically delivered includes: (1) an "individualized evaluation" to determine the child's needs and appropriate goals, (2) a "customized intervention," and (3) an "outcome evaluation" to document progress made towards the goals (American Occupational Therapy Association [AOTA], 2011).

School-based occupational therapists use a "holistic treatment approach" when working with children with disabilities (AOTA, 2011). Individualized treatment plans take into account the aspects of the occupational therapy domain: areas of occupation, client factors, performance skills, performance patterns, context and environment, and activity demands (AOTA, 2008). These aspects are of equal value and they interact with each other to influence the child's performance (AOTA, 2008). As a result, failure to take into consideration one of these aspects may affect the treatment outcomes. Also, these aspects need to be identified in order to provide a "just right challenge" intervention plan (Case-Smith, 2010, p. 5). An intervention plan that provides the child with an appropriate level of challenges can increase a child's motivation and engagement level in an activity. Therefore, a "just right challenge" intervention plan has great importance to a child's development of functional skills (Case-Smith, 2010). Since children with a diagnosis of ADHD typically have low levels of engagement due to their symptoms (Junod et

al., 2006), providing them with a "just right challenge" intervention plan may help increase engagement levels as well as improve academic performance.

Sensory integration (SI). Sensory integration (SI) as a theory originated from Dr. A. Jean Ayres, an occupational therapist and educational psychologist whose work has significantly influenced pediatric occupational therapy practice (Parham & Mailloux, 2010). SI describes the process of how the brain organizes and processes sensory input so that a child can make meaning out of an experience and form an appropriate adaptive response, an action that is purposeful and goal-directed (Ayres, 2005). Hence, the ability to make adaptive responses will allow a child to further develop complex integration of sensations, and ultimately he or she will be able to overcome the more difficult environmental challenges (Ayres, 2005; Parham & Mailloux, 2010). In other words, a child who is able to meet his or her environmental demands is more likely to acquire the underlying skills needed for academic learning and social competence (Ayres, 2005). However, an inability to integrate sensory input(s), also called sensory integration dysfunction, may lead to or look like symptoms associated with hyperactivity or distractibility, behavior problems, muscle tone and coordination problems, and learning difficulties (Ayres, 2005).

SI dysfunction is occasionally seen in children with a diagnosis of ADHD (Mangeot et al., 2001; Yochman, Parush, & Ornoy, 2004). The SI theory focuses on three proximal senses: vestibular, proprioception, and tactile. SI dysfunction occurs when a child is unable to produce adaptive behavior because his or her brain is not processing those underlying sensations well enough to be functional.

It has been noted that children diagnosed with ADHD have difficulties with integrating proprioceptive information in particular (Parham & Maillloux, 2010). Proprioception provides information about the body position through the muscles and joints (Ayres, 2005). Children with

poor proprioception may demonstrate problems in body sense, grading of movement, gross motor skills, and fine motor skills (Ayres, 2005). The proprioceptive system can be stimulated by activities that provide movements in the muscles and joints against gravity (Parham & Mailloux, 2010). Thus, activating the proprioceptive system is thought to help children with a diagnosis of ADHD execute successful adaptive responses.

Sensory integration therapy. The central principle of SI therapy is to "provide and control sensory input, especially the input from the movement (vestibular) system, muscles and joints, and skin in such a way that the child spontaneously forms the adaptive responses that integrate these sensations" (Ayres, 2005, p.142). SI therapy is most successful when the child is self-directed and shows active participation in the therapeutic activities (Ayres, 2005, Parham & Mailloux, 2010). Therapeutic activities should be carefully selected and performed in the context of play (Parham & Mailloux, 2010). Also, there needs to be an appropriate amount of freedom within the activities: too little freedom may lessen the opportunities for the child to make adaptive responses, but too much freedom may overwhelm the child and can have a negative effect on his or her performance (Ayres, 2005). Providing the right types of SI treatment activities or strategies will motivate the child and facilitate sensory experiences that are challenging to him or her (Parham & Mailloux, 2010).

SI treatment strategies that provide proprioceptive input may help regulate the level of arousal and/or increase attention amongst children with a diagnosis of ADHD and possible sensory integration dysfunctions (Mulligan, 2001). Therefore, activities that involve deep pressure or joint compression and traction may improve the classroom performance and outcomes of children with a diagnosis of ADHD. These activities may include chewing gum, sucking on a chewy object, fidgeting with little toys, weight bearing while engaging in children's

yoga, sitting on a seat cushion and/or bouncing on therapy ball, receiving deep pressure by wearing a weighted vest, participating in deep pressure exercises that involves joint compression and/or traction, and engaging in heavy work activities such as moving tables or carrying heavy book (Jensen & Kenny, 2005; Mulligan, 2001; Olson & Moulton, 2004; Pfeiffer et al., 2008; Sayers, 2008; Schilling et al., 2003; Witter, 1998).

Oral sensorimotor activities. One example of SI treatment strategies is oral sensorimotor activities. These activities include chewing or sucking on objects or food. The oral region contains various sensory nerve ending types and possibly has the most sensory nerve endings per unit than other parts of the body (Gairns, 1955). The high concentration of sensory endings in this region suggests that oral sensorimotor activities provide strong sensory stimulation that may increase one's arousal. Oral sensorimotor activities can help activate multiple sensory systems, such as the tactile, olfactory, gustatory, and proprioception. Oral sensorimotor activities have two motor components: the movement of the tongue and the repetitive motion of the temporomandibular joint. Researchers have found that free nerve endings and sensory nerve end organs at the temporomandibular joint are associated with proprioception and sensation (Asaki, Sekikawa, & Kim, 2006). As a result, oral sensorimotor activities are hypothesized to increase attention in children diagnosed with ADHD due to their involvement with multiple sensory systems, particularly the proprioceptive system.

In a published research study, Scheerer (1992) discussed the effects of a "chewy" on three children, ages of 5 years to 10 years, with sensory integration dysfunction. A "chewy" is a cylindrical piece of rubber tubing (Scheerer, 1992). The children were asked to consistently chew or suck on the "chewy" while observations on the children's behaviors were documented over a period of two years (Scheerer, 1992). This study focused on the frequency of use, when

and where the child used the "chewy," and whether there was a change in behaviors after the use of the "chewy" Scheerer, 1992. The results indicated that the "chewy" gave a calming, organizing, and focusing effect on the three children (Scheerer, 1992). However, due to the anecdotal nature of the study, such as lack of quantitative data and low number of participants, further studies on oral sensorimotor activities need to be investigated.

Gum chewing is another type of oral sensorimotor activity that is often preferred over the "chewy" because it is more socially accepted. In a single-subject study, Witter (1998) investigated the effects of gum chewing on non-attending behaviors in three 2nd grade students with the predominantly inattentive type of ADHD. The gum was chewed during silent reading periods. The results showed a reduced occurrence of non-attending behavior in two of the three students (Witter, 1998). Although, this study was limited because it had a small number of participants, a short study duration, and that participants were told why they were being given gum. The findings have provided some evidence about the effectiveness of gum chewing in children with ADHD, despite those limitations.

Another study at Baylor College of Medicine found that gum chewing improved math scores (Johnston, Tyler, Stansberry, Placic, & Foreyt, 2011). The study recruited 108 8th grade students and divided them into two groups, the control and the experimental group (Johnston et al., 2011). The students in the control group did not chew gum, whereas the students in the experimental group chewed gum while doing math homework or taking a math test (Johnston et al., 2011). After 14 weeks, students in the experimental group had a 3 percent increase in standardized math test scores compared to the control group (Johnston et al., 2011), illustrating a slight increase in academic performance associated with gum chewing.

Although there is some literature supporting the use of oral sensorimotor activities, there is scant empirical research directly investigating the effects of gum chewing on classroom performance. Therefore, this study helped in determining the effectiveness of gum chewing on performance when used in a natural classroom environment and contributed to evidence-based practice. The purpose of this study was to observe the effects of gum chewing on on-task behaviors, task completion, and quality of work in children who have a diagnosis of ADHD in an elementary school setting.

Method

Research Design

A single-subject (A-B) design was used, where "A" represented the baseline phase and "B" represented the intervention phase. There was a period of time in between the baseline phase and the intervention phase when data were not recorded in order to hopefully minimize the novelty effect. This design was selected for its usefulness in investigating the effectiveness of interventions on targeted behaviors for specific individuals (Deitz, 2006). A single-subject research design also allows the experimenter to better observe and document behaviors that may be hidden in the average of performances, as is commonly seen in large group studies (Kazdin, 1982). In addition, a single-subject research design has strong internal validity because each participant served as his own control, preventing threats such as selection biases or attribution (Deitz, 2006; Kazdin, 1982). Although an A-B-A design generally produces a stronger internal validity than an A-B design, it was impossible for this study due to the time constraint.

This study was conducted in a natural setting. Naturalistic observations allow the experimenter to examine the participants' behaviors and reactions to intervention in an unpredictable environment (Goodwin, 2004; Kielhofner & Fossey, 2006). However, a major

disadvantage of conducting research in a natural setting is the limited control over extraneous variables, making it difficult to determine the exact cause of the targeted behaviors (Goodwin, 2004).

Participants and Context

To be eligible for the study, participants must have had a physician's diagnosis of ADHD, be between the ages of 7-12, be a student from a 1st or 2nd grade classroom, and be able to independently masticate a piece of gum. The young elementary school-age group was chosen because, for the majority of children with ADHD, hyperactivity and inability to maintain attention is most prominent during the early school years (Rietveld, Bartels, Beijsterveldt, & Boomsma, 2004). Candidates were excluded from the study if they have co-existing diagnoses or if their classroom had participated in activities involving gum chewing prior to this study.

Two boys, aged 7 years, 10 months, and 8 years, 4 months, were recruited for this study from the same 2nd grade classroom at a private elementary school in Washington state. Both participants were on medication for ADHD. Participant 1 had been on Ritalin since 2010, whereas Participant 2 had been on Dextroamphetamine since 2007. Both participants did not receive any special education services.

The observations took place in the participants' classroom and occurred once a day during the daily writing period. The researcher collected data four times a week (Tuesdays through Fridays) for approximately four weeks. The assignments completed during the writing period varied in type, length, and level of difficulty from day to day. The types of writing included poems such as couplets, haikus, and cinquain, narratives, and persuasive pieces. The teacher worked with the researcher to select a mutual time for the writing task observation. The observation occurred between approximately 11:15am and 12:00pm from April 14th to May 8th.

However, due to scheduling complications, the observation on Wednesdays occurred between approximately 9:15am and 10:00am.

Instrumentation and Measures

Three instruments were used in the current study, including the Conners' Teacher Rating Scales- Revised (CTRS-R), Sensory Processing Measure (SPM): Main Classroom Form and Home Form, and Visual Analogue Scale (VAS).

Conners' teacher rating scales – revised (CTRS-R). The information derived from the CTRS-R was used to help the researcher operationalize the dependent variables for this study. The CTRS-R is a 59-item questionnaire that assesses symptoms and behaviors of ADHD in the classroom (Conners, 1997). It also evaluates related problems, such as those involving conduct, cognition, family, emotions, anger control, and anxiety (Conners, 1997). This assessment can be used for children between the ages of 3 to 17 years (Conners, 1997). The reliability of this instrument ranges from approximately .75 to .90 (Conners, 1997). The validity of this assessment was established by using factor analysis techniques on derivation and cross-validation samples (Conners, 1997).

Sensory processing measure (SPM). The SPM was selected because it provided information about the participants' sensory processing patterns. It was also used to help explain possible reasons as to why gum chewing did or did not have an effect on participants who displayed certain sensory processing issues. The SPM is an assessment of behaviors related to sensory processing issues, praxis, and social participation in elementary school children aged 5 through 12 years old (Miller-Kuhanek, Henry, Glennon, Parham, & Ecker, 2007). The SPM consists of three different forms: Home Form scales (75 items), Main Classroom Form scales (62 items), and School Environments Form scales. The Home Form and the Main Classroom Form

give information about social participation, vision, hearing, touch, body awareness, balance and motion, planning and ideas, and total sensory systems (Miller-Kuhanek et al., 2007). The researcher used both the Home Form and the Main Classroom Form in order to compare the behaviors at home to behaviors in the classroom (Miller-Kuhanek et al., 2007). For the purpose of this study, the School Environments Form scale was not used. The SPM is shown to have great reliability and validity, as evidenced in subsequent studies (Miller-Kuhanek et al., 2007).

Visual analogue scale (VAS). All data were collected using a visual analogue scale (VAS), an instrument used to measure a particular variable across a continuum (Gould, Kelly, Goldstone, & Gammon, 2001). In this study, these variables are on-task behaviors, task completion, and quality of work. A traditional VAS consists of a horizontal line that is 100 mm in length. Attached to each end of the line is an extreme descriptor of the variable (Wever & Lowe, 1990). A vertical line can be marked anywhere on the scale to indicate the scorer's perception of the variable (Wever & Lowe, 1990). The score of the VAS is the distance of left end of the scale to the vertical line using millimeters (Wever & Lowe, 1990). However, the traditional VAS was modified in the present study, but the purpose of the VAS was retained. The horizontal line of the modified VAS was divided into several intervals and had multiple descriptors for each variable (see Appendices A and B for score sheets). The same scoring method was applied to the modified VAS.

Dependent Variables

The term "classroom performance" referred to the following dependent variables: on-task behavior, task completion, and quality of work. On-task behavior was defined as consistent engagement in a writing task or related task assigned by the teacher (see Appendix C). This definition was constructed using three methods. First, the researcher reviewed past studies

relating to engagement to gain understanding about on-task behaviors (Watling & Dietz, 2007; VandenBerg, 2001). Second, the participants' most common behavior problems, as shown on the CTRS-R (Conners, 1997), were used as a guide to code off-task behaviors (see Table 1). Third, the participants' behaviors during the initial observations were documented; most of these behaviors were then coded as on-task or off-task. However, some of the observed behaviors were too ambiguous and difficult to categorize. For example, a participant sat quietly and stared at his paper, but he was not producing any work. Two hypotheses came out of that scenario: the participant was concentrated and thinking about how to do his assignment or he pretended to be concentrated so he wouldn't be in trouble for not doing his work. As a result, these behaviors were coded as "showed some difficulties" in the ability to demonstrate on-task behaviors.

Task completion was defined as the difference between the amount of work completed work by each participant and the mean amount of work completed by the class during the writing period (see Appendix D). The researcher worked with the teacher to operationlize task completion. Because of the different length and level of difficulties in all writing tasks, the researcher and the teacher agreed that by comparing of the participant's work to the class' work would allow the scores to be consistent throughout the study. After the writing assignments of the day were collected, the teacher reviewed the work of all the students in the class at the same time. Then the teacher used her best judgment to compare the amount of work completed by the participants to class's overall completion rate was on that day's assignment.

Quality of work was defined as the participant's overall performance on a writing assignment. The total score was based on the handwriting legibility, accuracy of the participant's work to the assigned writing task, and fulfillment of the six basic writing requirements (see Appendix E). The researcher explored multiple 2nd grade writing rubrics online and adapted one

of the rubrics from Oradell School District (2007) as well as modified the information to create a rubric that was more specific to this study. The rubric was also reviewed and edited by the teacher so that it could be more personalized to her classroom expectations.

Procedures

After the University Institutional Review Board (IRB) gave its approval, the researcher contacted principals of public and private elementary schools through email and phone, and who were within a 20-mile radius from the University of Puget Sound. Six principals expressed interest in this study and were asked to inform the teachers at their school about the research opportunity. Three teachers from three different private elementary schools responded as being interested in participating and felt that their student(s) met the research eligibility criteria. The selected classroom selected was chosen because it met the research criteria and had the greatest number of children with a diagnosis of ADHD.

Next, the researcher met with the classroom teacher to explain the details of the study and to obtain her consent. Then, the teacher helped to contact the participants' parents to inform them about the study and to obtain their consent. Upon receiving the parents' consent forms, the researcher met with each participant privately to obtain their assent. The child's assent form was read out loud to the two participants to ensure comprehension. At the same time, a letter with a brief description of the study activities was given to the guardians of non-participants in the classroom via the teacher. The guardians of non-participants were not required to sign a consent form to allow their child to participate in the study. However, they were able to refuse their child's participation in the study by notifying the teacher.

After consent and assent were obtained, the participants' parents completed the SPM: Home Form, and the teacher filled out the SPM: Main Classroom Form and the CTRS-R for

each participant. The researcher and the teacher then collaborated to create the VAS, definitions of the dependent variables, and gum chewing rules (see Appendix F). Next, began a two-day data collection trial period. This trial period was used to evaluate the ease and consistency of the scoring. It also allowed all students in the classroom to become familiar and comfortable with the researcher. The data collected during this period were not used. At this time, the VAS and definitions of the three dependent variables were slightly modified and refined.

During the baseline phase, the participants engaged in a task during writing period according to their usual routine. The baseline phase occurred over 6 days (1.5 school weeks). Before the intervention phase was a 2-day period to introduce the gum during writing period and to minimize the novelty effect. The gum selected for classroom use was sugarless and bubble gum flavored (BUBBLE YUM Original Bubble Gum by Hershey's). During the intervention phase, the participants and all other members of the class chewed gum while being engaged in a task during the writing period. The intervention also occurred over 6 days (1.5 school weeks).

Data Collection

Data were collected was limited to 12 observations due to the researcher's time constraints. The data collection procedures remained consistent throughout the study. Data regarding the participants' on-task behaviors were collected by the researcher, commencing after the teacher had given instructions for the daily writing assignment. Data were only collected for a total of 15 minutes of the 45-minute writing period. During the 15-minute observation, the researcher coded for target behaviors and marked one VAS at every 30-second intervals. No VAS was filled if researcher's vision was occluded, there was an emergency, a participant needed to use the restroom, the teacher gave out extra instructions, or the participant looked at the researcher. At the end of each 15-minute observation, the researcher was required to have 27

to 30 VAS marked, or the data collected for that day were discarded. The measurements of the 27-30 VAS were averaged to yield a single score for on-task behavior (see Appendix A). The researcher stayed after each 15-minute observation in order to prevent disturbance to the participating class. Meanwhile, the researcher used the remaining time of the writing period to further examine and to make general notes of the participants' behaviors. The researcher left the classroom when the students were dismissed to recess.

The daily writing assignments produced by the participants during the writing period were collected and scored by the teacher at the end of each day. The VAS for task completion was scored on the measurement of a single VAS (see Appendix B). In addition, the teacher was required to mark 8 VAS to determine the quality of each participant's writing. The scores of the 8 VAS were averaged to yield a single score for the quality of those writing products (see Appendix B). The researcher retrieved the data sheets from the teacher in the following observation period.

Data Analysis

The data gathered for each dependent variable (on-task behaviors, task completion, and quality of work) for both participants were plotted on separate graphs using Microsoft Excel (Carr & Burkholder, 1998). A visual analysis method was used to examine the effects of gum chewing on the classroom performance of children with a diagnosis of ADHD. This method mainly focused on the changes in mean scores, levels, trends, and the amount of variability that occurred across the A-B phases (Kazdin, 1982). In addition to the visual analysis, the 2-standard deviation band approach was used to provide descriptive information and enhance the visual data analyses. Data results were considered statistically significant ($p < .05$) if a participant's data demonstrated two consecutive points either above or below the band.

Results

CTRS-R and SPM

The participants' total scores on the SPM indicated possible concerns of sensory processing (see Tables 2 and 3). Both participants displayed no differences in the amount of problems reported on the Home Form and the Main Classroom Form. The SPM results suggested that the behaviors exhibited by the participants were similar and consistent at home and at school. Participant 1 did not score in the definite dysfunction range, but he appeared to have some problems with social participation, body awareness, balance and motion, and planning. Participant 2 had similar sensory problems as Participant 1; however, his scores also indicated there is a definite dysfunction in hearing.

The participants' scores were in the slightly atypical and mildly atypical range in at least 10 of the 13 subscales of the CTRS-R (see Table 4), indicating that there are rising behavioral concerns that may possibly cause problems to daily functions. Both participants scored in the markedly atypical range in the Conner's Global Index: Emotional Lability subscale, suggesting that they are likely to react emotionally to challenging situations. Participant 1 had a high score in the Anxious-Shy subscale, indicating that he is often sensitive to criticism and anxious in unfamiliar situations. Participant 2 had a high score in the Oppositional subscale, indicating that he is often likely to break rules, talk back to authority, and is easily annoyed.

On-Task Behaviors

The 2-standard deviation band method indicated no statistically significant difference between the baseline phase and intervention phase ($p > .05$) for both participants (see Figure 1). In the baseline phase, Participant 1's scores ranged from 41.4 to 81.5 mm (mean [M] = 64.6) and Participant 2's scores ranged from 35.2 to 75.0 mm (M = 51.0). The large amount of variability

seen in the baseline phase made it difficult for any data points in the intervention phase to exceed the 2-standard deviation band.

Although each participant responded to gum chewing differently, both demonstrated a negative effect on on-task behaviors while chewing gum. Participant 1's scores during the intervention phase indicated an inconsistent frequency of on-task behaviors (range = 46.4-78.6 mm; M = 63.4). He received a high score for on-task behaviors during the initial gum chewing observation, but scored lower as the number of observations increased. Participant 2's scores for on-task behavior were more consistent in the intervention phase than the baseline phase (range = 28.3- 56.7 mm; M = 41.3). However, the frequencies of on-task behaviors in the intervention phase were lower than the frequencies of on-task behaviors in the baseline phase.

Task Completion

Participants 1 and 2 completed approximately the same amount of work on each writing assignment during the baseline phase, but the amount of work completion rate fluctuated more during the intervention phase (see Figure 2). Participant 1's scores ranged from 75-80 mm (M = 76.8) during the baseline phase and 40-80 mm (M = 72) during the intervention phase. Participant 2's scores ranged from 65-76 mm (M = 71.2) during the baseline phase and 4-66mm (M = 30). Participant 2 demonstrated a statistically significant difference ($p < .05$) between the baseline phase and the intervention phase.

Quality of Work

Data indicated a negative effect of gum chewing on the quality of the writing assignments for both participants (see Figure 3). Participant 1's scores on quality of work were less consistent during the baseline phase (range = 46.3-70.5 mm; M = 61.0), but the scores were more stable during the intervention phase (range = 41.5-53.88 mm; M = 47.8). However, the scores received

for the quality of work in the intervention phase were lower than the scores for quality of work in the baseline phase. Participant 2's scores on quality of work were slightly more consistent during the baseline phase (range = 58.8-77.5 mm; $M = 68.4$) than during the intervention phase (range = 30.0-60.5 mm; $M = 52.15$). Participant 2 demonstrated a statistically significant difference ($p < .05$) between the baseline phase and the intervention phase.

Qualitative Data

Qualitative data were collected by summarizing the researcher's notes and conversations with the teacher. Participant 1 frequently rested his head on the table or his arms during instructional time. His ability to attend to the writing task immediately after instructions were given remained the same in both phases. He appeared to converse with peers less while chewing gum. The amount of times he approached the teacher to ask questions or to check his work remained frequent in both phases. He wandered around the classroom purposelessly or talked to himself more frequently during the intervention phase than the baseline phase. He also seemed more tolerable to longer writing assignments while chewing gum.

There was a greater variability in Participant 2's arousal level during instructional time. He frequently spent more than half of the writing period staring at objects in the room, talking to peers, or fidgeting with classroom items. These behaviors remained the same in both phases. During at least 6 out of the 12 observations, Participant 2 created an excuse to avoid engaging in writing task. The number of excuses occurred more frequently in the intervention phase than the baseline phase. During both phases, he was often more engaged in the writing task toward the last third of the writing period than in the first third of the writing period when data were being collected.

Discussion

The purpose of this study was to determine the effect of gum chewing on classroom performance in two 2nd grade students who have a diagnosis of ADHD. This study specifically examined the effects of gum on on-task behaviors, task completion, and quality of work. The results obtained from this study were inconsistent with the findings by Johnston et al. (2009), Scheerer (1992), and Witter (1998); their studies showed an improvement in the students' academic performance when chewing or sucking on objects. While the findings of this study appear to indicate that gum chewing had a negative effect on classroom performance, these findings cannot be concluded with confidence given the limitations of the study design and limited length of time.

Children with a diagnosis of ADHD have various sensory processing patterns (Dunn, 1999; Mangeot et al., 2001); therefore they may require more than one type of sensory-based strategy. In this study, the participants' results of the SPM (Home Form and Main Classroom Form) suggested that they have sensory integration difficulties in multiple sensory areas. For example, both participants exhibited some problems in the SPM Body Awareness and Balance and Motion. The teacher reported on the SPM that Participant 1 frequently leans on his desk or holds his head up with his hands, whereas, Participant 2 frequently wraps his legs around his chair and fidgets when seated at his desk. These behavioral concerns are related to the proprioceptive and vestibular system. In this study, the act of gum chewing was used to activate the proprioceptive system, but the vestibular system was not addressed. Perhaps combining gum chewing with a sensory-based intervention strategy relating to the vestibular system during the intervention phase would have been more appropriate for the two participants. In addition to having issues with the proprioceptive and vestibular system, Participant 2's SPM scores

indicated definite dysfunction for hearing. He had difficulties tuning out noises that were unnecessary to attend to in his environment. For example, he was frequently distracted from doing his work because he would attend to multiple irrelevant conversations led by his peers throughout the writing period. For children like Participant 2, gum chewing would probably be more effective if it was implemented in an environment that had a lower level of noise and/or distractions.

Also, the CTRS-R was used to highlight the most problematic behaviors of two participants and examine how these behaviors may have influenced the results of this study. The teacher reported that Participant 1 is an anxious and shy child, indicating that he may not adapt well to unfamiliar situations. As a result, his performance during the baseline phase and the intervention phase may have been affected due to the presence of the researcher and/or the gum chewing activity. Furthermore, both participants' scores were in the markedly atypical range in the Conner's Global Index: Emotional Lability subscale, suggesting that they are more likely to react emotionally in challenging situations than children who are developing typically. In other words, being presented with a task that is too difficult may cause frustration and work avoidance in the two participants.

The demands of the writing task may have had a stronger effect on the participants' performance than gum chewing as well. The writing assignments varied in type, length, and level of difficulty and were randomly selected by the teacher during each observation. During the baseline phase, the writing tasks were easy and consistent; however, they were long, difficult, and comprised of different types of writing pieces during the intervention phase. Participant 2's performance for task completion and quality of work appeared to correlate with the demands of the task: he had less variability during the baseline phase than the intervention phase. These data

indicated that the more inconsistent and/or difficult the assignment, the more inconsistent his performance. The high task demands during the intervention phase is also a possible reason for why both participants often had lower mean scores in the intervention phase than the baseline phase.

While the primary findings were inconclusive, preliminary secondary findings emerged from the study regarding the appropriateness of implementing gum chewing as an intervention strategy in the classroom for children with a diagnosis of ADHD and possible sensory integration issues. Although activating the proprioception system was noted in literature to be helpful treating children who are diagnosed with ADHD (Mulligan, 2001), this study found that other elements like the environment, activity demands, and other sensory systems may need to be taken into consideration as well.

The secondary findings in this study emphasize the importance of evaluating the aspects of the occupational therapy domain (APA, 2008). The aspects of the domain that were found to be most relevant to this study are the participant's needs, activity demands, and context. These aspects have a "transactional relationship," indicating that one aspect can influence another aspect (AOTA, 2008, p. 626). Because all these aspects are equally important and they interact with each other, each aspect has the potential to impact the participant's overall classroom performance. However, controlling the task demands and environment in this study was not feasible because the research took place in a natural setting. Also, the researcher did not implement intervention strategies in the classroom other than gum chewing. As a result, the participants may not have been provided with enough support to overcome the distractions in the environment or the challenges in the writing activities. More research is needed to determine the effectiveness of gum chewing on classroom performance.

Limitations

The validity of this study may have been limited by several factors. For example, the 4-week duration of this study was relatively short, and therefore the number of observations for each phase, as well as the number of times the participants chewed gum, were limited. The researcher may not have collected enough data in each phase to examine the actual performance of the participants or the effect of gum chewing. Another limitation is related to how on-task behaviors data were collected. Thirty-second intervals were too long, causing a lot of behaviors to be missed. There was also a challenge in operationalizing on-task behaviors and quality of work because of their multifaceted nature. The definitions might have missed important conditions, therefore affecting how the overall performances of the participants were measured.

Although naturalistic observations strengthened this study, the researcher's lack of control over extraneous factors made this type of observation a disadvantage as well. Examples of these factors include the type of activities that the participants engaged in prior to the writing period, the type, length, and the level of difficulty of the writing assignments, the behavior of the peers sitting around the participants during the writing period, the occasional presence of substitute teachers, etc.

Also, this study used an AB design instead of an ABA design, causing problems to the internal validity. No causal statement could be made about the results due to the type of design used. The study had a small sample size, which decreased the statistical power and created issues with generalizability. Moreover, the study did not have interrater reliability. The researcher collected all data points for on-task behaviors variable and the general education teacher collected all data points for the task completion and quality of work variable. Biases were a concern because the teacher was informed about the purpose of the study and gum chewing was

a noticeable activity. As a result of limitations in this study, these data on the effect of gum chewing should be viewed cautiously.

Implications

Despite the results of this study, occupational therapists may still consider gum as an intervention strategy given other studies (Johnston et al., 2009; Scheerer, 1992; Witter, 1998) indicating possible positive benefits. However, occupational therapists using this intervention should use good data base decision making on functional, target behaviors to determine if the gum chewing is having the anticipated affects on classroom performance.

The secondary findings in this study suggest that gum chewing should not be used alone in an intervention plan. It is recommended that in addition to implementing gum chewing, occupational therapists focus on adapting the environment and activity to fit the needs of the person with a disability. Furthermore, in order to ensure that gum chewing is an appropriate sensory-based intervention strategy for the individual, it is suggested that the occupation, context, and the child's needs be evaluated and reassessed throughout the occupational therapy process.

Occupational therapists therefore need to be skeptical of studies that only focus on a single sensory-based treatment strategy. It is recommended that occupational therapists carefully analyze the research design and limitations of those studies before concluding the effectiveness of the treatment strategy. A study's findings of the targeted behaviors may not always be a direct cause of the implemented sensory-based treatment strategy. Other events in the environment that are occurring simultaneously as the sensory-based treatment activity can also be potential causes. Therefore, it is recommended that occupational therapists cautiously interpret the results of those studies in order to determine if the treatment strategy is reliable and suitable for each individual.

Future Research

Although the data in this study indicates a decrease in classroom performance in children with ADHD when chewing gum, not all results were statistically significant. In order to increase the probability of a study yielding statistically significant results, future researchers may want to consider the sample size, sample demographics, study design, and duration of study in their research studies. Recruiting more participants can increase the statistical power of the study, broadening the sample demographics can help resolve the generalizability concerns, changing to a withdrawal design (A-B-A or A-B-A-B) can strengthen the internal validity, and extending the study can yield more data points to further support the results.

Future research related to this study would be beneficial to add information to the literature on the effects of gum chewing in children with attention difficulties. It would be interesting to investigate the most effective ways to implement gum chewing, future studies examine the length, duration, frequency, and type of gum used. That being said, the researcher noted that Participant 2 appeared more focused during the second half of the writing task than the first half, indicating that the gum may not be as effective immediately. Perhaps allowing Participant 2 to chew gum before the writing period would increase his performance versus during the task. Finally, continued investigation regarding the sensory-based intervention strategies and the importance of activity demands and environment could be sought to further support the secondary findings of this study. With new future studies, more knowledge about sensory integration interventions can be gained.

Summary

This study examined the effects of gum chewing on classroom performance in two 2nd grade boys who have a diagnosis of ADHD using a single-subject study (A-B design). The

participants were scored on a visual analogue scale for on-task behaviors, task completion, and quality of a writing task. The scores were used to compare the participants' performance when they were not chewing gum to when they were chewing gum. The findings are inconsistent with the results of previous studies conducted by Johnston et al. (2009), Scheerer (1992), and Wittter (1998), which showed that chewing or sucking on objects can improve students' classroom performance. While the findings of this study appear to indicate that gum chewing had a negative effect on classroom performance, these findings are inconclusive given the limitations of the study design. Secondary findings of this study indicate the child's needs and strength, environment, and activity demands are important to consider when implementing sensory-based integration strategies like gum chewing. Further research is recommended to understand the appropriateness of using gum chewing as a SI intervention strategy.

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Appendix A

Researcher's Score Sheet

Student's Initial: _____ Date: _____
Researcher's Initial: _____

Please provide a short description of the student's behavior at the beginning of the activity:
_____
_____
_____
_____

How well did the student follow instructions today? Place a vertical mark on the line below to indicate the student's ability to follow instructions based on the given criteria stated in the research study. Place a mark every 30 seconds until the activity ends or for 15 minutes.

1. Showed difficulty _____ Showed Some _____ Showed proficiency
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____

25. _____
26. _____
27. _____
28. _____
29. _____
30. _____

Please provide a short description of the student's behavior during or at the end of the activity:

_____
_____
_____
_____
_____
_____
_____
_____

Appendix B

Teacher's Score Sheet

Student's Initial: _____ Date: _____
Teacher's Initial: _____
Please write a short description of the writing activity:
_____
_____

How complete was the student's work today? Place a vertical mark on the line below to indicate how complete was the student's work based on your expectations of a 2nd grade classroom.

Slight Moderate Average

Shown No Work _____ Exceedingly Completed

How well did the student do on the writing assignment today? Place a vertical mark on the line below to indicate the assignment's quality of work based on your expectations of a 2nd grade classroom.

Handwriting
Unsatisfactory Partially Proficien Proficient _____ Advanced

Form of Writing
Unsatisfactory Partially Proficien Proficient _____ Advanced

Content
Unsatisfactory Partially Proficien Proficient _____ Advanced

Organization
Unsatisfactory Partially Proficien Proficient _____ Advanced

Sentence Structure
Unsatisfactory Partially Proficien Proficient _____ Advanced

Word Choice
Unsatisfactory Partially Proficien Proficient _____ Advanced

Language Convention
Unsatisfactory Partially Proficien Proficient _____ Advanced

Voice
Unsatisfactory Partially Proficien Proficient _____ Advanced

**** Please attach the student's work sample with this score sheet.*

Appendix C

On-task behavior is the consistent engagement in a writing task or related task assigned by the teacher. It is the participant's ability to (1) write consistently during a writing task in seat, (2) keep eyes focused on own work, (3) explain writing task to peers, (4) disengage self in activities or conversations that is unrelated to writing task, and (5) quietly and independently work on other class work after finishing writing task as instructed.

Showed Difficulties

- Eyes wander around classroom
- Eyes focus at work of other peers
- Eyes fix on conversations of other peers
- Performs unrelated tasks (e.g. wanders around room, biting nails, napping, tapping pencils, or drawing on table)
- In conversation with peers about unrelated topics (e.g. conversation does not involve answering or asking clarifying questions about writing task)
- Talks with peers or wanders around the classroom when finished with writing task

Showed Some Difficulties

- Eyes look at own work, but is not writing
- Gathers the needed materials or performs a purposeful task (e.g. student needs to sharpen pencil, grabs a dictionary/thesaurus or an eraser, or shows work to teacher) even though the task was not instructed by the teacher
- In conversation with peers or teacher to ask for clarifying questions
- Mostly sits quietly when finished with writing task

Showed Proficiency

- Eyes are looking at own work and writing at the same time
- Answering clarifying questions about writing task while being in or out of seat
- Quietly doing other related work when finished with writing task

Appendix D

Quality of work is based on legibility of his or her handwriting, accuracy of the participant's work to the assigned writing task, and fulfillment of the six writing traits (content, organization, sentence structure, word choice, language convention, and voice).

Unsatisfactory

- Handwriting is neat, easy to read, and well formed 25% of the time
- Writing is inconsistent with the instructed writing form
- Rarely stays on topic, uses no/little supporting details, and uses no/few descriptive words
- Writing has little logical sequence
- Writing has few/no complete sentences and few sentences make sense
- Uses extremely limited vocabulary
- Writing shows weak evidence of success with grade-level expectations for conventions; there are many significant error which makes the writing hard to read
- Writing lacks emotion, creativity, individuality, and/or personality

Partially Proficient

- Handwriting is neat, easy to read, and well-formed 50% of the time
- Writing is partially consistent with the instructed writing form
- Occasionally stays on topic, includes some supporting details, and uses some descriptive words
- Writing has some sequential order, writes some complete sentences, and some sentences make sense
- Uses familiar, ordinary words that lack specificity
- Writing shows moderate evidence of success with grade-level expectations for conventions; there are few significant errors
- Writing has some emotion, creativity, individuality, and/or personality in the writing

Proficient

- Handwriting is neat, easy to read, and well-formed 75% of the time
- Writing is mostly consistent with the instructed writing form
- Mainly stays on topic, uses supporting details frequently, and uses descriptive words frequently
- Writing reflects logical sequence
- Writing has mostly complete sentences and sentences make sense
- Chooses some words for specificity and stretches to use new words beyond writer's spelling ability
- Writing shows strong evidence of success with grade-level expectations for conventions and errors
- Expresses some emotion, individuality, and/or personality in the writing

Advanced

- Handwriting is neat, easy to read, and well-formed 100% of the time
- Writing has all the elements of the instructed writing form and has author's style and creativity
- Consistently stays on topic, uses logical, supporting details, and uses effective descriptive words
- Writing has a fluent, logical sequence
- Writing has complete sentences and all sentences are related and make sense
- Uses words and phrases to create a picture in the reader's mind
- Writing shows a thorough understanding and consistent application of grade-level conventions and writing is error-free

Writing criteria were adapted from "2nd Grade Writing Rubric" by Oradell School District, 2007, Retrieved from http://www.oradell.k12.nj.us/gradepages/Second/2.LA.htm.

Appendix E

Work completion is the amount of the work that was completed by the student compared to the work completed by the class at the end of the writing task.

Not Completed

- Student completed 0% of the work at the end of the writing task.

Slightly Completed

- Compared to the class completion rate, student completed 25% of the work at the end of the writing task.

Moderately Completed

- Compared to the class completion rate, student completed 50% of the work at the end of the writing task.

Completed (Average)

- Compared to the class completion rate, student completed 75% to 100% of the work at the end of the writing task.

Exceedingly Completed

- Student completed more work than the class completion rate at the end of the writing task.

Appendix F

Classroom Rules for Gum Chewing

1. Gum must be chewed immediately when it is given.
2. Gum can only be chewed during the writing period.
3. Gum must be thrown away in the trashcan if the student leaves the classroom or is not within the teacher's line of sight.
4. No blowing bubbles or making disruptive noises with the gum.
5. Students can throw away the gum in the trashcan anytime during the writing period.

Table 1

Behaviors Frequently Exhibited by Each Participant as indicated in the Conner's Teacher Rating Scale – Revised: Long Version

Participant 1	Participant 2
Items Marked as "Very Much True" by teacher	
Fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities	Has a difficulty organizing task or activities
Fidgets with hands or feet or squirms in seat	Argues with adults
Shy, withdrawn	Short attention span
	Loses things necessary for tasks or activities
	Distractibility or attention span a problem
	Does not follow through on instructions and fails to finish schoolwork
	Easily distracted by extraneous stimuli

Table 2

T Scores and Interpretive Range on the Sensory Processing Home Form

Participant	Social Participant	Vision	Hearing	Touch	Body Awareness	Balance and Motion	Planning and Ideas	Total
1	62*	62*	43	47	61*	61*	60*	58
2	66**	50	71**	57	57	47	61*	59

Note. T score mean = 50; standard deviation = 10. 40T-59T = typical range; 60T-69T = some problems;
70T-80T = definite dysfunction.
[+] typical range *some problems **definite dysfunction

Table 3

T Scores and Interpretive Range on the Sensory Processing Main Classroom Form

Participant	Social Participant	Vision	Hearing	Touch	Body Awareness	Balance and Motion	Planning and Ideas	Total
1	68*	57	56	63*	65*	69*	66*	64
2	61*	65*	59	58	68*	64*	66*	65

Note. T score mean = 50; standard deviation = 10. 40T-59T = typical range; 60T-69T = some problems;
70T-80T = definite dysfunction.
[+] typical range *some problems **definite dysfunction

Table 4

Scores and Interpretive Range of the Conner's Teacher Rating Scale – Revised: Long Version

Subscales	Participant 1	Participant 2
Oppositional	64	79**
Cognitive Problems/Inattention	59	57
Hyperactivity	66*	62
Anxious-Shy	71**	58
Perfectionism	56	62
Social Problems	62	50
Conners' ADHD Index	62	65
Conners' Global Index: Restless-Impulsive	59	61
Conners' Global Index: Emotional Lability	77**	72**
Conners' Global Index: Total	66*	66*
DSM-IV: Inattentive	63	66*
DSM-IV: Hyperactive-Impulsive	63	62
DSM-IV: Total	64	65

Note. 45-55 = Average; 56-60 = Slightly Atypical; 61-65 = Mildly Atypical; 66-70 = Moderately Atypical;
70+ = Markedly Atypical
*Moderately Atypical **Markedly Atypical

Figure 1. On-Task Behaviors

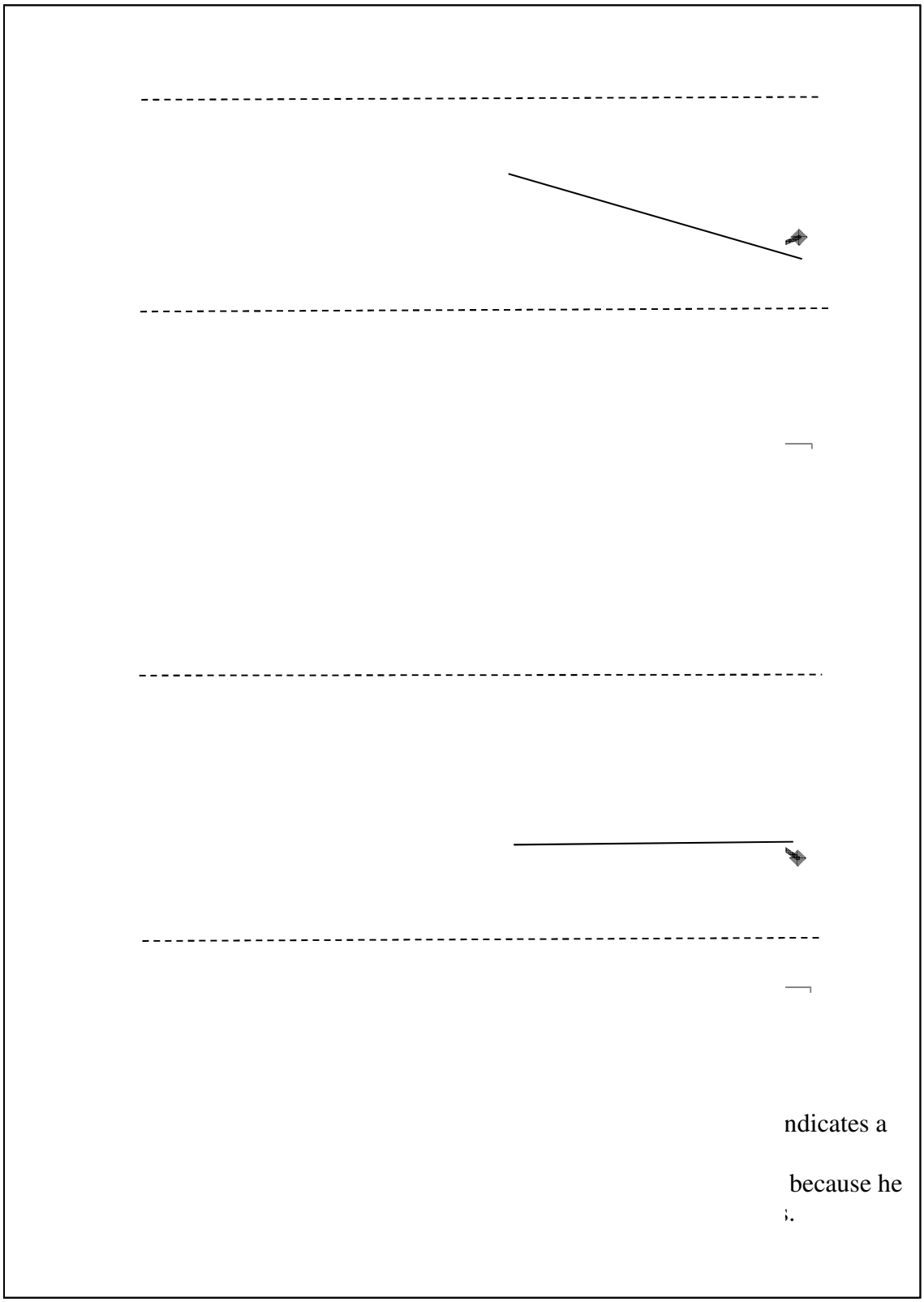


Figure 2: Task Completion Score

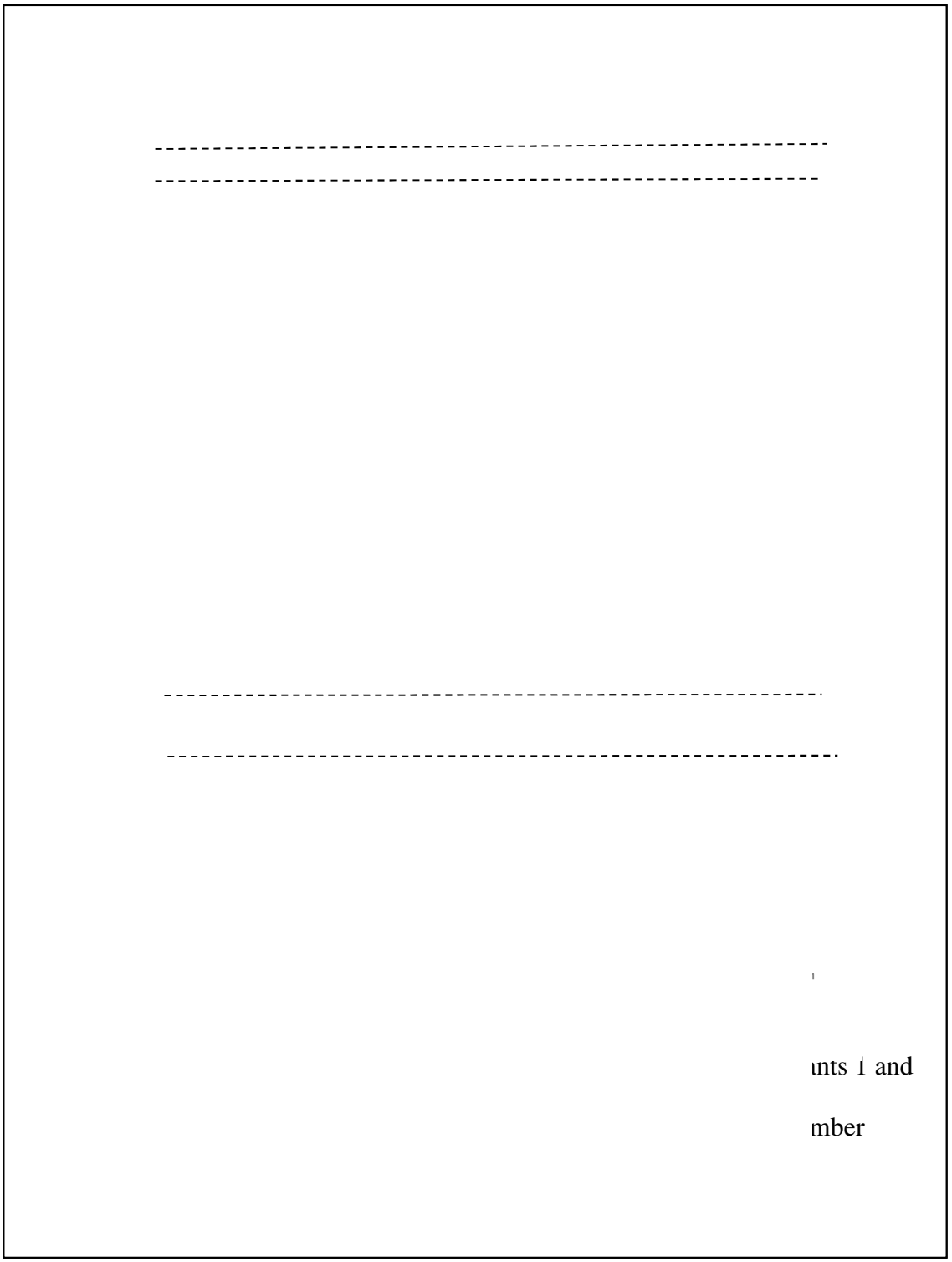
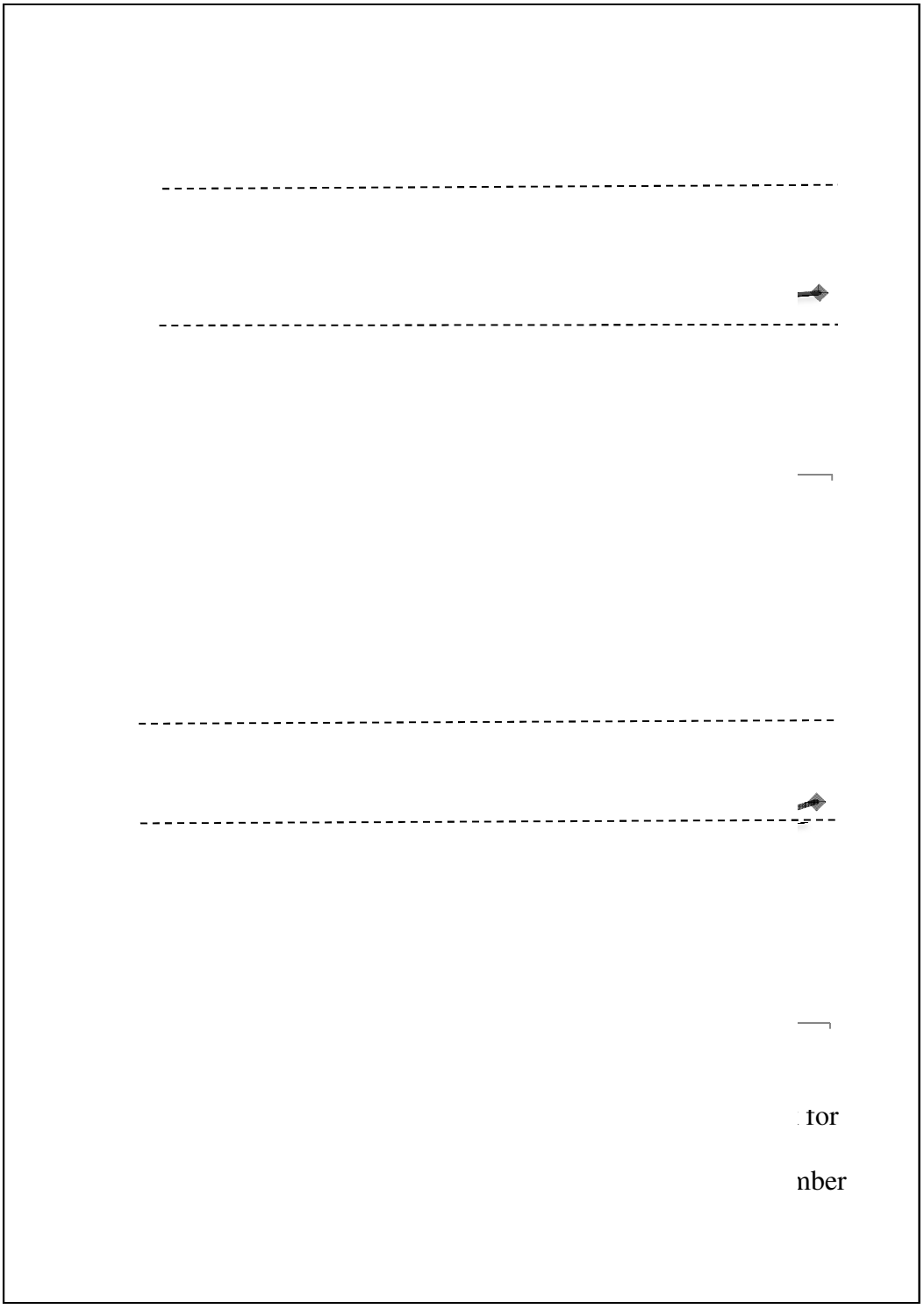


Figure 3. Quality of Work Score



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