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Comparing the Efficacy of Interventions Derived from Concurrent Operant Analysis and Indirect Assessment

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COMPARING THE EFFICACY OF INTERVENTIONS DERIVED FROM CONCURRENT OPERANT ANALYSIS AND INDIRECT ASSESSMENT

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
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ABSTRACT OF THESIS

COMPARING THE EFFICACY OF INTERVENTIONS DERIVED FROM CONCURRENT OPERANT ANALYSIS AND INDIRECT ASSESSMENT

In this study, a simultaneous treatments design was used to conduct a concurrent operant analysis (COA) to evaluate the choice making behavior of one elementary aged student. The COA results were used as a possible reinforcer for one of the conditions for the intervention to increase work completion. An indirect assessment, Questions about Behavioral Function (QABF), was used identify a hypothesized function to the student's lack of task completion behavior. The results from thee QABD were used as a possible reinforcer for one of the conditions for the intervention to increase work completion. An alternating treatments design (ATD) was used to compare the percentage of work completion between the intervention derived from the COA results, the intervention derived from the QABF results, and how normal classroom sessions were conducted (baseline). Results from the COA showed that COAs could be conducted in the school setting and lead to an interpretable outcome. The results of the ATD showed that interventions derived from a COA and a QABF lead to a higher percentage of work completion, compared to baseline.

KEYWORDS: Indirect assessments, QABF, Concurrent operant analysis, work completion, functional analysis

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INTRODUCTION

Concurrent Operant Analysis

A concurrent operant analysis (COA) is implemented by having two or more conditions available at the same time with access to each condition contingent on a response from an individual, thus meaning the individual needs to make a choice between which condition they prefer to engage (Fisher & Mazur, 1997). The implementer is able analyze the data collected during a COA to evaluate the preference the participant has for one condition compared to the other. The results have been shown to predict the value a reinforcer has on a participant (Fisher et al., 1992), which "suggests that COAs can be used to identify reinforcers for appropriate behaviors" (Lloyd et al., 2020, p. 86). COAs could be a better alternative to a functional analysis, because it is designed to avoid problem behavior altogether. Casey (2001) developed a COA framework that included a total of six conditions and eight possible choice areas that were adapted from conditions originally described by Harding et al. (1999). This framework used concurrent operant arrangements for each condition to test the value of tangible, escape, and attention reinforcers for an individual's appropriate choice-making behavior. With this framework, the implementer has a better understanding of the function that aligns with the participant's choice-making behavior. In Lloyd et al. (2020) the researchers used the framework from Casey's (2001) study to identify reinforcers for task completion for students that engaged in low levels of task completion. In the study the researchers implemented a COA and used the results to inform the individualized interventions for the participants in the school setting. The results showed that using a COA to inform an

intervention for increasing task completion was effective for those participants in the school setting.

Berg et al. (2007) compared a COA to a functional analysis in a school setting. In the Berg and colleagues (2007) article the authors tested one function (i.e., attention, escape, tangible, alone) at a time per condition during the functional analyses (Iwata et al., 1982/1994). The results showed that for three out of four of the participants the results between the COA and functional analysis matched. They described the match as, "the same class of reinforcement maintained both sets of behavior" (Berg et al., 2007, p. 549). An unpublished dissertation by Allen (2019) replicated the Berg et al. (2007) study. During the COAs in Allen's (2019) study, the participants engaged in almost 0% of problem behavior across the conditions and had almost 100% engagement with the activities presented. When comparing the data from the FAs and the COAs, there were only two conditions where the functional analysis results were misaligned with the COA results. Relatedly, Casey (2001) compared results from a brief functional analysis to the results of COAs in a clinic setting with 23 participants. For 10 of the participants, the functional analysis results were inconclusive, but conclusive for each participant with the COA. For those 13 participants with conclusive results for both assessments, nine of the results aligned fully or at least partially aligned. This yielded 69% agreement between the brief functional analysis and the COA.

Indirect Assessment of Behavioral Function

Functional analysis has long been considered the gold standard to identifying the function of problem behavior. The results obtained from a functional analysis inform the decisions to create function-based treatments (Campbell, 2003). Although a functional analysis is

the gold standard for identifying the function of an individual's problem behavior, the assessment may be impractical to implement without having the necessary resources (e.g., trained staff, protective equipment). When working with a student who has severe problem behavior, there may be ethical implications with conducting a functional analysis. Khang et al. (2015) discussed how an functional analysis can possibly lead to a short-term increase in the rates of problem behavior and injuries to the student, compared to what happens in their normal day-to-day life. Indirect assessments such as the Questions About Behavioral Function (QABF; Matson & Vollmer, 1995) can be used when these ethical issues are present. The results from the QABF have been shown to correlate with the outcomes from functional analyses and have successful treatment outcomes when the developed intervention is based upon the function identified from the QABF (Dignan, 2016). The QABF is a 25-question indirect assessment that uses a Likert-type scale to answer the questions that were created to pinpoint a target behavior. The implementer of the assessment takes the scores from the answers given by the adult that knows the child's behaviors well and sums up the total score from five different categories it is testing for: attentions, escape, non-social, physical, and tangible. The QABF can be completed and scored in 20 min (Matson et al., 2012). Healy and colleagues (2013) compared identified functions from the QABF and functional analyses for 32 participants. For 24 (75%) of those participants they identified an exact match. An exact match was defined as both assessments suggesting the same function (Tarbox et al., 2009). Another 6 (18.75%) participant's results showed a partial match between the two assessments. A partial match was defined as suggesting at least one of the same

functions. These findings have been replicated by different groups of researchers (Matson et al., 1999; Smith et al., 2012).

Rationale

There are ample amounts of research comparing the results of functional analyses to the QABF (Fee et al., 2016; Healy et al., 2013; Matson et al., 1999; Paclawskyj et al., 2001; Smith et al., 2012) and an evolving body of research comparing COAs to a functional analysis (Allen, 2019; Berg et al., 2007; Casey, 2001). However, there have not been studies that have compared the efficacy of interventions derived from COA results compared with interventions derived from indirect assessment results. To do this we did a partial replication of Lloyd and colleagues (2020) study, in which we used a COA to identify a potential reinforcer to inform an intervention to increase work completion. COAs and indirect assessments offer the same types of benefits to the implementer when compared to conducting functional analyses. Both the COA and an indirect assessment are more resource sensitive when compared to the functional analysis. Although indirect assessments are not the gold standard for identifying the function of a child's behavior, they are still a viable option in many situations (e.g., risk-assessment suggests indirect assessment as preferred option moving forward; Wiskirchen et al., 2017). When an indirect assessment is the appropriate assessment, a COA could also be a great direct measure to support the creation of a function-based intervention plan. Given that there are situations in which a functional analysis may not be feasible, there is still a need to understand the relative efficacy of interventions derived from assessments such as the COA and QABF. In the literature there are no comparisons of intervention designed based on the results of a QABF and a COA. Therefore, I sought to examine the relative

efficacy of interventions derived from results of the QABF and the COA. Three research questions were addressed in this study:

1. Can the COA framework produce results that lead to the identification of a reinforcer to increase work completion?
2. Can the QABF produce results that lead to the development of an intervention for increasing work completion?
3. To what extent does the COA align with the results of an indirect assessment measure (i.e., QABF)?
4. When the results of a COA and QABF differ, do interventions based on these results lead to differences in work completion?

METHOD

Participants

Potential participants were students enrolled in the research team's local school district and receiving services in publicly funded classrooms. The inclusion criteria for participation was that a student (a) was within the age range of 5-12 years old, (b) attended a publicly funded school, (c) attended school for at least 90% of school days during the school year, (d) engaged in low levels of task-completion compared to same-aged peers, (d) referred for behavior support services or currently receiving services under the categories of intellectual disability, other health impairment, or specific learning disability, (e) able to independently transition from one place to another without the need for physical or mobility supports, (f) able to follow one-step directions, and (g) able to wait at least 3 s for a prompt. The inclusion criteria were assessed through initial classroom observations (e.g., antecedent-behavior-consequence data collected two days a week for four weeks), and teacher interviews. Exclusion criteria for participants included students who engaged in challenging behavior that was dangerous to themselves or others (i.e., scratching, hitting, head banging).

One student participated in this study. Max was an 11-year-old white male in fifth grade at a Title 1 public elementary school. Max had a diagnosis of attention deficit hyperactivity disorder and received special education services under the eligibility category of other health impairment. Max spent the majority of his school day in the general education classroom but received special education services for writing in a resource classroom for 30 min per day. Data collected during the teacher interview were the most informative on if Max met our criteria. The special education teacher, who has

worked with Max for 4 years, was able to provide us with key detailed information on each component of our inclusion criteria. For example, when the special education teacher was asked about the Max's task completion, she went back through her permanent product examples and through her gradebook to confirm that the he engaged in less than 50% task completion. Through our initial classroom observation, we were not able to quantify how much work he was completing due to our position within the classroom. Once the Max met criteria and was selected, informed consent was obtained from the participant's legal guardian and verbal assent was received from the participant before data collection began.

Research Team

Two graduate-level students in an Applied Behavior Analysis master's program served as the primary investigators. Primary investigator one (PI one) was a 24-year-old white male, and primary investigator two (PI two) was a 24-year-old white female. Both investigators spoke English as their primary language, and they received their undergraduate degrees in special education with an emphasis in learning and behavior disorders and moderate to severe disabilities for grades K-12. A school district Board Certified Behavior Analyst was also a member of the research team who assisted with study coordination between the research team and the participating student's school-based service providers.

Settings and Materials

The COA, QABF, and all study sessions were conducted in Max's special education resource classroom. During the QABF, the only materials needed were a writing utensil and a printed QABF form. During the COA, choice areas were

represented by two 0.76 m by 1.47 m tables with two chairs at each of them. The tables were separated by a 1.68 m by 1.47 m empty space. This allowed the student to sit at one table and engage with the materials at that table (e.g., playing with toys, responding to task demands). A mobile application called Countee (Gavran & Hernandez, 2022; see Appendix A) was used to collect data during the COA sessions. Materials in each condition within the COA represented which items were present in each of the choice areas (e.g., task materials, high preferred items, moderate-low preferred items). An interview with Max's special education was conducted to determine which items he preferred for high preferred and moderate-low preferred items (e.g., "What are some of Max's favorite items to engage with during his break times?"). The primary investigators also conducted an informal interview with Max right before the COA to consider his personal preferences in the assessment (e.g., "When you have a break, what is your favorite thing to play with?"). The investigators observation notes also informed the selection of materials for the assessment (see Table 1).

Table 1 *COA Materials by Choice Area*

Choice Area	Description
A: Demand without attention	Max sits alone and completes work independently with writing worksheets
B: Free Play with attention and preferred items	Max plays with primary investigator and preferred items (Tic Tac Toe, Connect 4. Chromebook)
C: Directed Play with preferred items (no attention)	Primary investigator prompts Max how to play with preferred items (Tic Tac Toe, Connect 4, Chromebook)
D: Free play with preferred items (no attention)	Max plays alone with preferred items (Tic Tac Toe, Connect 4, Chromebook)
E: Demand with attention	Primary investigator provides prompts and assistance to complete writing worksheets
F: Alone	Max sits alone in area without any items or activities

G: Free Play with attention and low preferred items	Max plays with primary investigator and low preferred items (Sensory toys)
H: Free play with low preferred items and no attention	Max plays alone with low preferred items (Sensory toys)

Study sessions comparing interventions derived from the results of the QABF and COA were conducted during Max's scheduled writing work time. Materials included writing worksheets and writing utensils. Writing worksheets were provided by the classroom teacher and were part of Max's typical writing instruction. That is, Max would have been given these worksheets regardless of his participation in the study. The worksheets included approximately one writing prompt per page and were double sided, so two writing prompts per session. The writing prompts consisted of asking him to pick from two options of which he liked more, to draw a picture of what he picked and explain why he chose the option he did. An example is, "Which instrument do you like better, drums, or piano? Explain why. Draw a picture." (See Appendix B).

Measurement System & Response Definitions

Concurrent Operant Analysis

For COA sessions, we measured the amount of time the Max allocated his time in one of three choices (i.e., Choice A, Choice B, and No Choice). Choice A referred to the activity on the table on the left side of the COA area; Choice B referred to the activity on the right side of the COA area; and No Choice referred to any area away from Choice A or Choice B. Choice allocation was defined as Max being within arm's reach of a choice area (i.e., the table representing the area) with a 3-s onset. Examples include Max sitting

in the chair at the table representing Choice A. Non-examples include Max getting up to grab an activity from another part of the room. No choice was defined as Max being more than an arm's length away from the choice area with a 3-s onset. An example includes Max walking around the classroom. Nonexamples include Max sitting/standing within arm's reach of the choice area.

The primary investigators used a free mobile application on their phones called Countee (Gavran & Hernandez, 2022; see Appendix A) to record durations using timed-event recording. On the application there were three different buttons that corresponded with the available choices for the COA sessions, which allowed the data collectors (i.e., primary investigators) to simply touch whichever button corresponded to the choice area with which Max was engaged at any given time. Max's duration of allocation with a particular choice area was started after 3 s of consecutive engagement. At the end of each session the PIs calculated the percentage of time that Max engaged with each choice area by summing the number of seconds allocated to a specific choice area divided by the total duration of the session, then multiplying by 100.

Questions About Behavioral Function

Max's special education teacher answered the questions read to her alongside PI one QABF form (Matson & Vollmer, 1995) and afterward the primary investigators scored the assessment. The QABF used a Likert-type scale for the 25 questions about the target behavior, which was lack of task completion, and how often it occurred.

Comparison of COA and QABF Interventions

A permanent product data collection system was used to compare interventions derived from the COA and QABF, from which the primary investigators measured Max's

percentage of work completion (i.e., dependent variable). Using the worksheet that was presented to Max during his independent writing time, the primary investigators identified the number of questions to which Max provided a completed answer. A completed answer was defined as, Max answered all identified parts of the prompt and wrote in complete sentences when instructed to write. A completed sentence needed to contain at least four words, with at least one being contextually relevant to the prompt, and include a subject, verb, and at least one of the following: adjective, adverb, preposition, or noun. This definition of a completed answer was informed by a discussion with the special education teacher and what she would count as complete on a worksheet. We also got the special education teacher to fill out a blank worksheet as if she were Max and he completed the whole worksheet up to her expectations. Work completion was calculated by dividing the number of completed answers by the total number of questions on a worksheet and multiplying by 100.

Experimental Design and Analysis

Concurrent Operant Analysis

COA sessions were implemented within a simultaneous treatments design (Ledford & Gast, 2018) in which there was a predetermined sequence of comparisons that would be presented across the sessions (Casey, 2001; see Figure 2). This design was used to analyze the student's choice allocation behavior with two concurrently available conditions each session. Sessions were 5 min in duration, and two conditions were compared within each session. A session could be repeated if Max did not allocate at least 70% of his time to one choice area. Compared conditions were changed each session when Max allocated at least 70% of their time to one choice area throughout a

session. The data were analyzed by following the flowchart (see Figure 2) and the choice area that received at least 70% of Max's choice allocation, when Max got to the last condition of the flowchart, was selected as the identified reinforcer. The controls to threats to internal validity for simultaneous treatments designs are described below in Table 2 (Ledford & Gast, 2018).

Table 2 *Threats to Internal Validity for the Simultaneous Treatments Design*

ST Design	Control
Procedural fidelity	Primary investigators trained to criterion and were re-trained on the implementer behaviors again if necessary.
Instrumentation	The primary investigators created clear definition of the choice allocation behavior. Also, the primary investigators trained to criterion before conducting the assessment. When non-agreements occur, the primary investigators discuss why they had a disagreement.
Hawthorne Effect	Max met the primary investigators prior to beginning assessment. They had been in the classroom for about two weeks prior to the assessment.
Instability	PI two provided clear instructions for Max to make a choice. Max had been previously exposed to the stimuli in the choice areas. PI two would repeat sessions if needed (i.e., 70% of the session was not allocated to one choice area.
Adaptation	PI two clearly described the stimuli what were present in each choice area.

The results from the COA were compared to the results from the QABF (described below) to determine if the assessments aligned and identified the same potential functions contributing to Max's low percentage of work completion. For

example, an alignment would be counted if both assessments identified tangible as the potential function.

Questions About Behavioral Function

The primary investigator scored the completed document by adding up the scores for each possible category (e.g., attention, escape, non-social, physical, tangible). Each category had five questions asking about that specific category throughout the questionnaire. The category that received the highest numerical score was selected for each student to use as the function-based reinforcer for the QABF condition of the intervention.

Comparison of COA and QABF Interventions

We used an alternating treatments design (ATD) to compare the effects of the QABF identified function-based reinforcer and the COA identified reinforcer, on Max's work completion. A baseline condition was also included throughout the design (described below). An ATD was chosen to allow the primary investigators to be able to rapidly alternate between the various intervention conditions and the baseline condition (Ledford & Gast, 2018). To evaluate the data, the primary investigators used visual analysis to identify if one condition was more effective than another by looking at the levels of the data paths. Looking at the levels of the data paths allows for the investigator to see if there was any response differentiation between the two interventions and baseline conditions. An intervention was deemed to be more effective for a student if the level of work completion was higher across 80% or more series of conditions compared to the other conditions (Wolery et al., 2018). Threats to internal validity and how we attempted to control for them are presented in Table 3.

To begin our ATD, we started with a baseline condition and planned to conduct a minimum of at least three data points before moving onto the intervention comparison condition, as long as the data were stable and below our criterion or decelerating in a contratherapeutic trend. The intervention comparison condition started once that occured. Once the intervention condition started the order of sessions were randomized within 5 block sessions, such that baseline occurs one time. This allowed the investigators to determine if it was truly the intervention making the change in Max's behavior Also, randomized sessions were used to help control for the possibility of multi-treatment interference.. The investigators hypothesized that in the presence of the interventions the percentage of work completion would increase. When analyzing the data paths within the intervention condition, using an ATD allowed us to be able to compare the COA intervention data path to the QABF intervention data path, the COA intervention data path to baseline data path, and the QABF intervention data path to the baseline data path. When comparing data path's we looked compared data point to data point (e.g., COA data point 1 to QABF data point 1).

Table 3 *Threats to Internal Validity and How they were Controlled for*

ATD	Control
Procedural fidelity	Both primary investigators were trained to criterion with the procedures. If implementer behaviors fell below 80% of correct behaviors, PI one would be retrained to fidelity.
Instrumentation	Primary investigators created a clear response definition for completed work. Both primary investigators were trained to criterion on scoring work completion.

Hawthorne Effect	Max met the primary investigators prior to beginning assessment. They had been in the classroom for about two weeks prior to the beginning of baseline starting.
Multi-treatment interference	Condition were clearly defined and during intervention conditions visual discriminations and an auditorial cue were provided. For example, the QABF and COA reinforcers were written in orange and blue, respectively, at the top of Max's worksheet. That was also paired with a verbal statement of which reinforcer he is working for. Sessions were randomized, so the same intervention session was not repeated more than two times back to back within a 5 block chunk.
Adaptation	The primary investigators collected baseline until it were stable or below criterion
History	When in baseline, data were collected continue until data were stable or below criterion. When in the intervention comparison condition data collection continued until differentiation between phases and baseline.

Procedures

Question About Behavioral Function

The QABF was given to the primary teacher after consents were obtained from the participant's caregivers. The primary investigators read through the QABF with the participant's special education teacher. The primary investigator provided further examples to the teacher for questions that were unclear when she asked for asked for a better explanation. For example, the QABF asked a question about if the participant engaged in the behavior because they are physically uncomfortable. The primary investigator provided a further example saying, "Does Max ever itch himself when he

isn't wanting to complete his work?" Once the primary investigator finished filling in the teacher's answers for the QABF, the primary investigator scored the document.

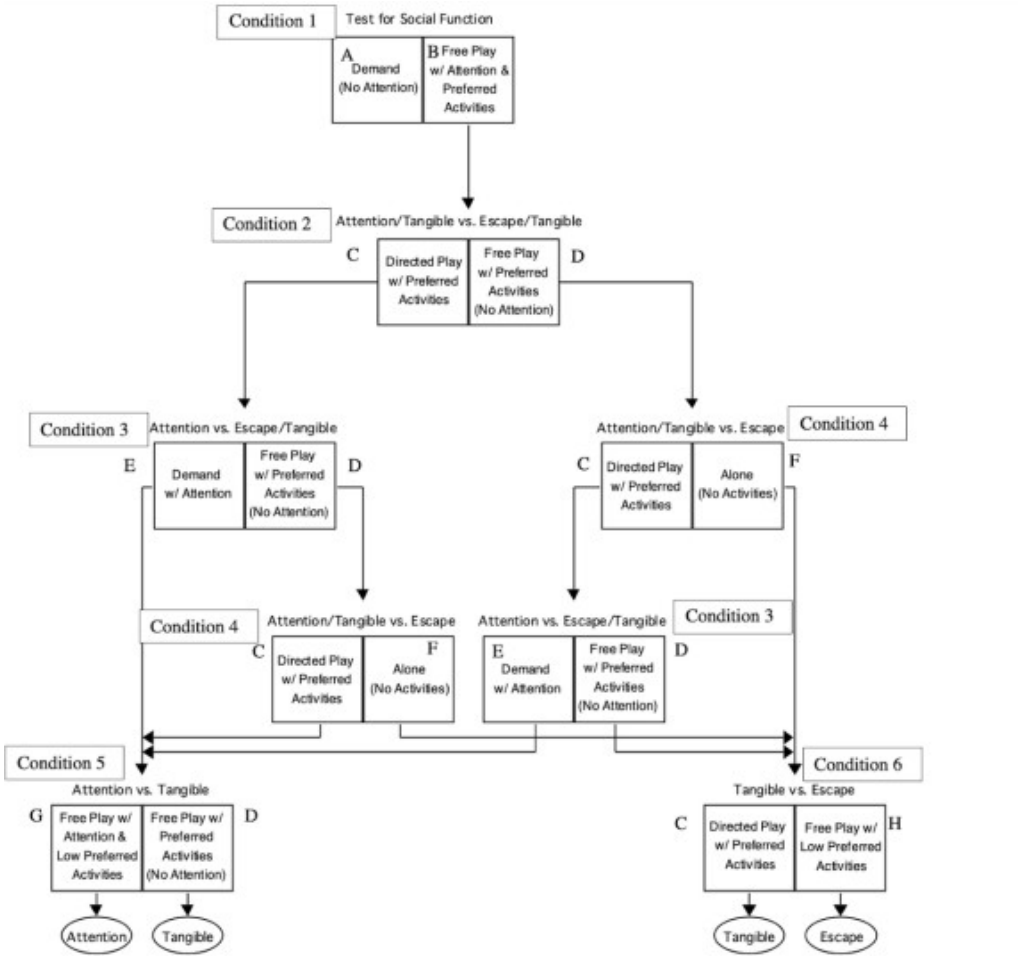
Results. Once PI one finished going through the QABF with the special education teacher, he scored the document. The results from the category asking about a tangible function totaled 11 points. The results from the categories asking about an attention and escape function totaled 10 points each. The results from the category asking about a non-social function totaled 8. The lowest total was the physical category at 2 points. The data analyzed from the QABF allowed the primary investigators to integrate a tangible reinforcer in the QABF intervention sessions.

Concurrent Operant Analysis

The COA was implemented by PI two. PI one served as the attention provider during COA sessions in which attention was tested as a possible reinforcer, and the other investigator collected data during these sessions. The teacher reported that Max enjoyed attention from anyone, especially males. When selecting the materials for each choice area, we used the information from the teacher interview and asked Max what items within his classroom he liked to engage with when he has free time. The COA lasted 20 min for Max and was completed within one school day. The primary investigators used the framework created by Casey (2001; see Figure 2) to guide their decision making on how to select the conditions that would be present each session and the order they would be presented. The order of the conditions depended on the student's responding and choice allocation. Casey's (2001) framework includes a possibility of six different concurrent choice conditions (see Figure 2; modified from Casey, 2001). With those 6 different concurrent choice conditions, there were eight possible choice areas. During

each session, two of those eight possible choice areas were presented concurrently at the two identified tables in the room. The materials put at each table were decided by the COA flowchart. For example, in Condition 2, Choice area C is on the left side of the flowchart, so during the assessment it was placed at the table on the left. So, Choice area D and its materials were placed at the table on right because it is on the right side of the flowchart.

Figure 1 *Casey (2001) framework for working through COA conditions*



Prior to each session of the COA, PI two asked the student to join them in the No Choice area (e.g., “Max come stand in front of me, so I can explain our choices?”). Then PI two explained the two choice areas and told Max that he can switch choices at any

point throughout the session. Then PI two asked the student if they had any questions before the session began. PI two answered questions, if any were asked, and then stated, "make a choice" and that is when the 5-min condition began on the Countee application. Approximately every 2 min during each session, PI two reminded the student that they could change their choice if they would like. These procedures were repeated for each session.

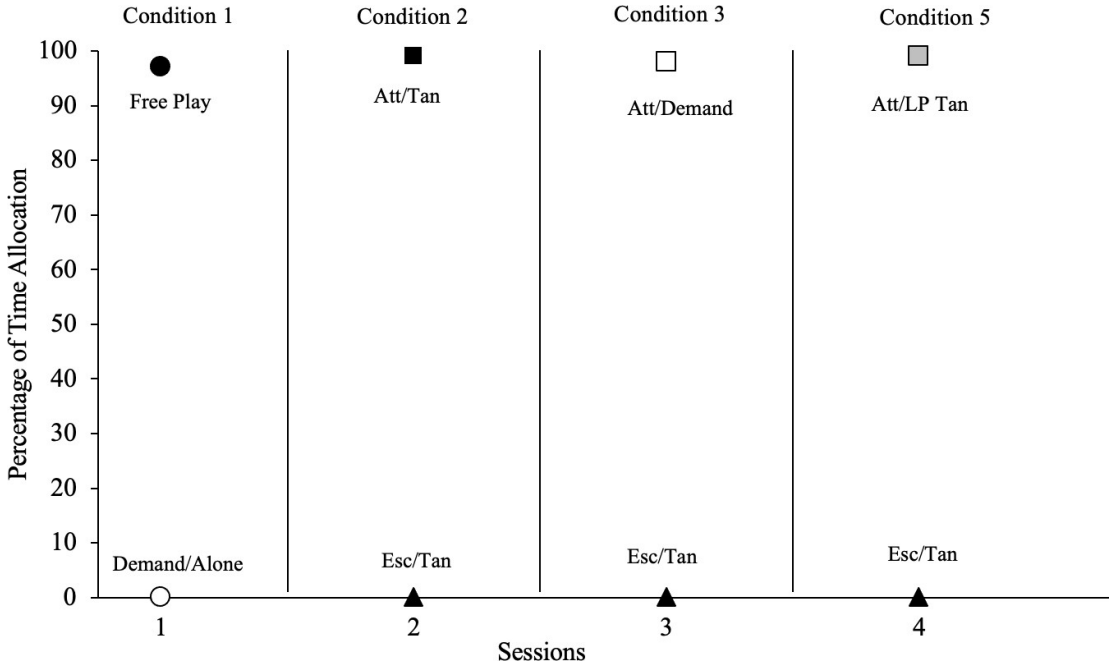
Results. Max's results demonstrated that he had a clear preference for choice areas where attention was a component, which suggests that attention could be a possible reinforcer for work completion (See Figure 1). These results answer research question one "Can the COA framework produce results that lead to the identification of a potential reinforcer to increase work completion?" Throughout each COA session, Max chose to allocate almost the entire 5 min to one choice area.

During session one, Max allocated 97% of his time to the choice area in which he had access to free play with his preferred items and attention from the primary investigator. This indicates that his behavior is socially mediated. In session two Max allocated 99% of his time to the choice area in which he engaged in directed play with preferred activities. This indicates that he had a preference for having access to attention over escaping demands. In session three Max allocated 98% of his time to the choice area where he received task demands from the primary investigator. This indicates that he had a preference for having access to attention over escaping task demands and having access to tangibles. In session four Max allocated 99% of his time in the choice area where he had access to attention from the primary investigator and access to low preferred items. This indicates that he had a preference for having access to attention over having access

to highly preferred tangibles. This data allowed us to integrate attention as one of the identified reinforcers for Max's work completion during the COA intervention sessions.

Then the primary investigators analyzed the identified reinforcers from the QABF and COA to see if they aligned. An alignment between the two assessments would be if they both produced the same results, such as the COA and QABF both identifying attention as the notified reinforcer. We were able to come to the conclusion that the COA and QABF produced different identified reinforcers, attention and tangible respectively.

Figure 2 *Results from Max's COA*



Note. Tan = tangible; Esc = escape; Att = attention, LP= low preferred

Comparison of COA and QABF Interventions

Baseline condition. Baseline sessions lasted 5 min. The baseline condition required at least three stable data points or demonstrating a decelerating trend in a contratherapeutic direction. In addition, Max needed to complete 50% or less of his work

over a minimum of three consecutive sessions prior to introducing the intervention. Baseline sessions were implemented by PI one. These sessions mirrored the procedures used by the classroom teacher during the student's independent writing times. Sessions began by the PI one making all materials were ready (e.g., worksheet, pen, 5-min timer). Then PI one let Max know that it was time to work and to move to his desk if he wasn't already there. Once he was seated at his desk PI one read the directions on the writing worksheet, letting him know how many questions there were, to write in complete sentences, and how many supporting sentences were required if he was asked to pick why he liked one thing over another. Then Max was provided with the task direction of "It's time to start working, you are working for a 5 min break where you can just relax." Then the 5 min work timer was started. Throughout the session if Max engaged in attention seeking behavior (e.g., whining, dancing, or starting conversation unrelated to task) he was ignored. If Max had a question related to the task, PI one could engaged with him briefly. Once the 5 min timer was up, the PI one would collect the worksheet and let Max know he can have his break and start the timer for the break. Once the break timer is up, PI one let Max know his break was up.

After the third baseline session, a modification was added to better align with the teacher's typical procedures. During these sessions, PI one provided Max with feedback on his work from the previous session by putting a checkmark beside each question that was completed and by telling Max reasons for why each checkmark was provided. For example, PI one would say, "You got a check mark for this sentence, because you had at least four words and included a subject, verb, and a noun."

Intervention comparison condition. Throughout the intervention comparison condition, three types of sessions were randomly alternated: (a) baseline, (b) QABF intervention, and (c) COA intervention. Randomization occurred within five-session blocks, such that two QABF intervention sessions, two COA interventions sessions, and one baseline session were randomly alternated. Randomization occurred using a random number generator to assign a number to each of the five possible sessions. The order of the sessions was then determined based on the sequence of generated numbers when ordered from smallest to largest. All sessions were 5 min. The intervention conditions were implemented by PI one, who also provided attention as the COA-based reinforcer. Two sessions were collected each day, for four days a week. Sessions conducted on the same day were spaced 5-10 min apart. Baseline sessions that were conducted during the intervention comparison condition were implemented in the same manner as during the baseline condition.

QABF and COA intervention sessions began by PI one letting the student know that it was time to work and move to their desk (if not already there). They would let Max know what reinforcer he was working for (QABF tangible reinforcer, COA attention reinforcer) and write it on the top of the worksheet in specific color with a marker (orange for QABF, blue for COA). For QABF intervention sessions, Max was allowed to pick which tangible he wanted to work for (e.g., Chromebook, tic tac toe, Connect 4) and write whichever he picked at the top of the paper in an orange marker. For COA sessions, PI one would write “Hangout with Mr. Lane” at the top of the worksheet with a blue marker. Once Max was seated at his desk PI one read the directions on the writing worksheet, letting him know how many questions there were, to write in complete

sentences, and how many supporting sentences were required if he was asked to pick why he liked one thing over another. Then Max was told that each instance of completed work earned him a checkmark and was told what he earned from each checkmark (e.g., each checkmark equals 30 s of reinforcement). Before starting, PI one would ensure that Max had time to ask any questions he might have, then answer his questions if necessary. Then sessions would begin by PI one giving the task direction of "It's time to start working, you are working to ___ (i.e., hangout with Mr. Lane or play with toys). Each checkmark you get by the end gives you 30s with ___. You can do as much or as little of the worksheet as you want, you have 5 min." Then PI one would start the 5-min timer. Throughout the session if Max engaged in attention seeking behavior (e.g., whining, dancing, starting conversation unrelated to task) he was ignored. If Max had a question related to the task, PI one engaged with him briefly. Once the 5-min timer was done, Max was told that time is up, and he could stop working. Then PI one scored the worksheet in front of Max, giving him a checkmark for each step that was complete according to the work completion definition and letting him know why he got a checkmark. PI one added up all the checkmarks and let Max know how much time he had to access his reinforcer (e.g., 3 checkmarks= 1 min 30s, 8 checkmarks= 4 min, etc.). Then a timer was started for however long Max got access to the reinforcer. Once that timer went off, Max was told that his break was over.

Interobserver Agreement

The primary investigators were the only two people trained to collect IOA for the COA, baseline, and intervention sessions. They were trained to 90% of agreements and the training for the COA took place at a university-based clinic where the primary

investigators explained how data were to be collected via the Countee application and they practiced in-vivo. An agreement was counted if the on-set of a choice allocation was collected ± 3 s between two data collectors. IOA training for baseline and intervention conditions were conducted via zoom using a permanent product from the participant. IOA for all sessions were calculated using the point-by-point method (# of agreements/(# of agreements+ # of disagreements) x 100). IOA was collected for 100% of the sessions for each condition for our participant. We monitored IOA after each session that it was conducted to see if there had been any observer drift. If issues arose where we had less than 80% of agreements, we retrained on the definitions of the behaviors being observed.

IOA was collected for 100% of the COA sessions and ranged from 66% to 100% of agreements. During session 1 of the COA, the IOA between the primary investigators was 66% of agreements. It should be noted that there were only three data points to compare. So, the primary investigators agreed on 2 out of the 3 data points. During the following three sessions, the primary investigators IOA was 100% of agreements. The average IOA across all sessions was 92% of agreements.

IOA was collected for 100% of the baseline and intervention comparison sessions and all of the sessions were at 100% of agreements (see Table 4).

Procedural Fidelity

Concurrent Operant Analysis

The primary investigators were trained at a university-based clinic. The implementer behaviors observed during the COA sessions included: (a) gathering materials for the COA condition and placing them in the correct choice area, (b) prompt the student to come stand by you in the neutral zone, (c) explain each choice area

correctly, (d) asked the student if they had any questions, (e) remind student once about every two min that they can switch choice areas whenever they'd like to. Procedural fidelity data was collected for 100% of baseline sessions. The formula used to calculate procedural fidelity # of behaviors observed/(# behaviors observed+ # of behaviors not observed) x 100. If a problem arouse where the implementer's implementation fell below the 80% minimum of agreement, then the implementer would be retrained until they reached 90% agreement again. During the COA sessions, PI two's behaviors were observed at 100% of correct behaviors across all 4 sessions (see Table 4).

Comparison of COA and QABF Interventions

PI two took procedural fidelity on PI one's implementer behaviors**.** Baseline sessions implementer behaviors included: (a) materials were ready, (b)Told max it was time to work, provided feedback from previous session during baseline two(c) provided direction (d) started the 5 min session timer, (e) throughout the session if Max engaged in attention seeking behavior (e.g., whining, dancing, or starting conversation unrelated to task) he was ignored,(f) if Max had a question related to the task, the primary investigator engaged with him briefly, (g) once the 5-min timer was up, the implementer would collect the worksheet and let Max know he could have his break and start the timer for the break, (h) once the break timer is up, the implementer let Max know his break was up. During all eight baseline sessions PI one's implementer behaviors were observed at 100% accuracy. (see Table 4).

During intervention sessions the behaviors observed included: (a) materials were ready, (b) told Max it was time to work, and let him know what reinforcer he was working for and wrote it on the top of the worksheet, (c) provided direction, (d) started

the 5 minute session timer, (e) throughout the session if Max engaged in attention seeking behavior (e.g., whining, dancing, or starting conversation unrelated to task) he was ignored, (f) if Max had a question related to the task, the primary investigator engaged with him briefly, (g) once the 5-min timer was up, the implementer would score the worksheet and (h) let Max know how much time he accessed his reinforcer and start the timer for the break, and (g) once the break timer is up, the implementer let Max know his break was up. Procedural fidelity data was collected for 100% of intervention sessions. If a problem arises where the implementer fell below the 80% minimum of agreement, then the implementer would be retrained until they reached 90% agreement again. Procedural fidelity was calculated with the following formula (# of behaviors observed/(# behaviors observed+ # of behaviors not observed) x 100). During intervention sessions PI one's implementer behaviors ranged from 92% to 100% of correct behaviors across all sessions. There were two sessions (session 9 and 15) in which PI one's implementer behaviors were at 92% of correct behaviors (see Table 4). During session 9, PI one did not to write the reinforcer (Hangout with Mr. Lane) on the top of the worksheet before explaining the directions of the worksheet to Max. During session 15, PI one did not provide feedback to Max on why he received a checkmark. For example, PI one said, "You got a checkmark here", and did not give any reason as to why Max received a checkmark.

Table 4 *IOA and PF for all Sessions*

	COA			
Participant	% of sessions	Mean IOA % of agreements	Mean PF % correct behaviors	% of sessions
Max	100%	92%	100%	100%

		Baseline		
	% of sessions	Mean IOA % of agreements	Mean PF % correct behaviors	% of sessions
Max	100%	100%	99%	100%
		Intervention		
	% of sessions	Mean IOA % of agreements	Mean PF % correct behaviors	% of sessions
Max	100%	100%	98%	100%

RESULTS

Max's work completion data that were collected within the context of a single-case ATD were displayed in Figure 4. During pre-intervention baseline sessions, the data were variable with work completion percentages that ranged in level from 12.5% to 71.4% across the eight pre-intervention baseline sessions. No clear trend was observed. Throughout all eight pre-intervention baseline sessions, 87.5% of the data points were at or below the criterion of 50% of work completion criterion. The between conditions component of visual analysis, overlap, was used to analyze if there were any data points in the intervention comparison condition that were within the same range as the pre-intervention baseline condition data path. When analyzing the QABF intervention data path, we concluded that there was 100% of non-overlap with the pre-intervention baseline condition data points. When analyzing the COA intervention data path, we concluded that there was 67% of non-overlap and 33% of overlap with the pre-intervention baseline data points.

During the intervention comparison condition, there was not an immediate effect for the COA intervention. The COA intervention's data were stable moving in an accelerating therapeutic trend until session 4 of the COA intervention. Then the data were at ceiling moving in a zero-celerating trend. The data levels were moderately-low to high in level and ranged from 33% to 100% work completion. The data for the QABF intervention showed an immediate effect when moving from the baseline condition to the intervention comparison condition. The QABF intervention data were stable moving in an accelerating therapeutic trend until session 3 of the QABF intervention. Then data were at ceiling with a zero-celerating trend. The data levels were high in level and ranged

from 86% to 100% work completion, with the last four sessions of the intervention all being at 100% work completion. The baseline path in the intervention comparison was variable with no observable trend. The data levels ranged from 37.5% to 87% work completion.

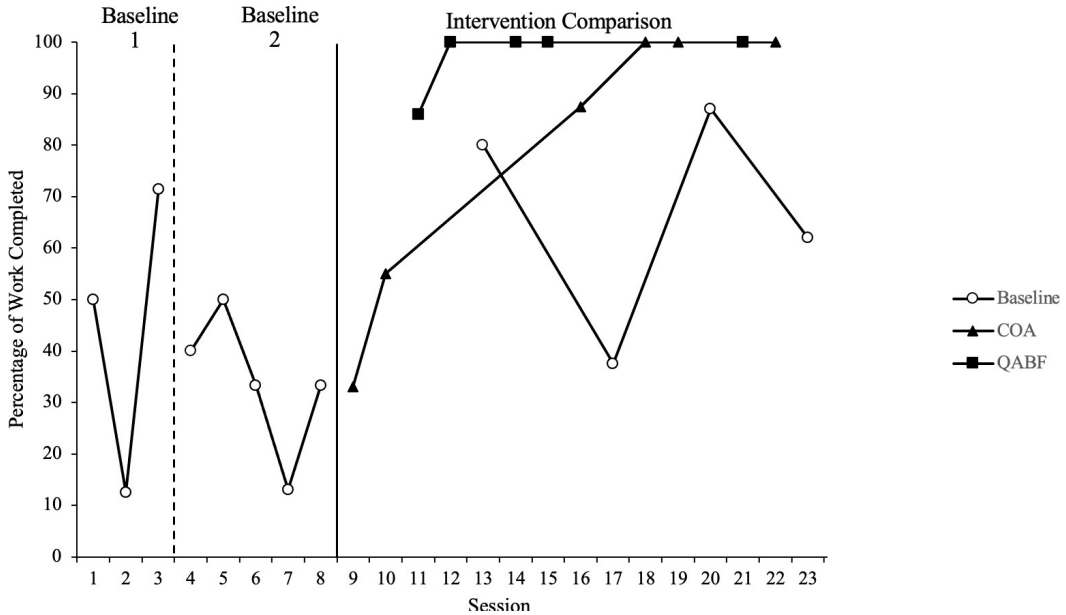
When we compared the COA intervention to the QABF intervention there was differentiation between the two data paths for the first three sessions of each intervention, and then both were at ceiling for the remainder of the study. Then we compared data point to data point, session 1 of the COA intervention was at a low level of 33% and session 1 of the QABF intervention was at a higher level of 86% work completion. Session 2 of the COA intervention was at moderate level of 55% work completion and session 2 of the QABF intervention was at a higher level of 100%. Session 3 of the COA intervention was at a high level of 87.5% and session 3 was at a higher level of 100%. Session 4 and 5 of both interventions, COA and QABF, were at a high level of 100%. There was 60% non-overlap and 40% overlap between the COA and QABF data paths. There is no superiority between the COA and QABF interventions, on which is more effective.

When we compared the COA intervention data path to the baseline data path. The session 1 of the baseline condition shows a higher level of 80% work completion compared to the session 1 of the COA intervention at a lower level of 33% work completion. Session 2 of the baseline condition was at a low level of 37.5% work completion and session 2 of the COA intervention was at a slightly higher level of 55% work completion. Session 3 of the baseline condition was at a high level of 87% work completion and session 3 of the COA intervention was at almost the same level at 87.5%

work completion. Session 4 of the baseline condition was at a moderate level of 62% work completion and session 4 of the COA intervention was at a higher level of 100% work completion. There was 50% non-overlap and 50% overlap between the baseline data path and the COA intervention data path.

When we compared the QABF intervention to the baseline condition, session 1 of the baseline condition was at a high level of 80% work completion and session 1 of the QABF-based reinforcer condition was at a higher level of 86% work completion. Session 2 of the baseline condition was at a low level of 37.5% work completion and session 2 of the QABF intervention was at a higher level of 100% work completion. Session 3 of the baseline condition was at a high level of 87% work completion and session 3 of the QABF intervention was at a higher level of 100% work completion. Session 4 of the baseline condition was at a moderate level of 62% work completion and session 4 of the QABF intervention was at a higher level of 100% work completion. There was 100% non-overlap between the baseline condition and the QABF intervention.

Figure 3 *Max's ATD Results*


Baseline 1
Baseline 2
Intervention Comparison
Percentage of Work Completed
100
90
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Session
Baseline
COA
QABF

DISCUSSION

The purpose of this study was to extend the literature on the use of COAs to increase work completion, as well as compare the results of the COA to an indirect assessment that is often used in place of a functional analysis (QABF). No research has previously been done on the correlation between the results from a COA and an indirect assessment, like the QABF. To answer research questions one and two, the results of the COA and QABF were able to produce results that allowed for a clear identification of a potential function-based reinforcer. To answer research question three, the results of the COA and QABF did not align and produced results of attention and tangible respectively. As this is an initial study comparing the two different assessments, it was not a surprise that the results did not align between them as the research comparing COAs to functional analyses had discrepancies in identifying the same function. Also, the research comparing the results of the QABF to functional analyses had discrepancies in identifying the same function.

The present data suggest that the interventions derived from the QABF and COA are both effective and reached 100% work completion during sessions. The QABF showed a stronger immediacy of effect compared to the COA, which took until session 4 to reach 100% work completion. This could be possible due to Max's motivation being higher to work for receiving access to tangibles compared to receiving attention from a novel adult. The tangible that Max selected for every QABF intervention session, besides one, was to work for access to his Chromebook; while the other tangible he worked for one time was access to sensory toys. So, the activities he engages in while on the Chromebook seem to have a more reinforcing value. It should be noted that when Max

received access to his tangible reinforcer there were no adverse effects that happened to the classroom environment (e.g., peers upset that Max had access to his Chromebook). The other students in the class also had access to tangible reinforcers while they were working, such as edibles for snack time. Also, it could be possible that Max did not prefer the novel attention of PI one throughout the first three sessions, especially since it is just engaging in conversation with PI one and not receiving access to tangibles concurrently. It should be noted that during some reinforcement periods of the COA intervention sessions Max tried to engage in conversation with the special education teacher. When these situations occurred the special education teacher would ignore Max.

Ecological Validity

During the baseline and intervention sessions, the primary investigators were able to use writing worksheets that the student was already using, and sessions were conducted during the normal independent writing time in the resource classroom. This demonstrates evidence of ecological validity, as the primary investigators did not have to disrupt Max's normal daily schedule or introduce novel materials and tasks. The use of the intervention conducted in this study was easy to implement, since it consisted of writing the reinforcer the student was working for at the top of the worksheet.

For the COA sessions, we were able to conduct them within Max's resource classroom during a time that no other students were in the room. Unlike Lloyd and colleagues (2020), we made no environmental modifications to the student's classroom (i.e., marking off choice areas with tape on the ground). The tables that were already in the classroom were used and were kept in the same spot. This allowed the primary investigators to be able to keep the environment as natural as possible. To help with

reducing the novelty of the assessment we were able to use stimuli for the choice areas that were already available in the classroom (e.g., Tic Tac Toe, Connect 4, Max's Chromebook, and sensory toys). With these things listed above, it suggests that a COA may be able to be used in authentic settings.

Differences and Similarities with Past COA research

Lloyd and colleagues (2020) also used the Casey (2001) COA framework to identify potential function-based reinforcers. Lloyd and colleagues (2020) also had a similar dependent variable as ours being the of number of items complete and another dependent variable of percentage of time engaged; the only dependent variable in our ATD was percentage of work completion. Lloyd and colleagues (2020) used token boards and tokens to give to the students contingent upon work completion. They had 10 tokens, and each token was given contingent upon work completion and gave the student access to 30 s of their specified reinforcer. We decided to use checkmarks in a similar manner as their token boards, because Max was a 5th grader and none of his classmates had token boards. The difference between our study and Lloyd and colleagues (2020), is that in their study they gave the student tokens throughout the 5-min session. While in our study, we provided the checkmarks at the end of the 5-min session. This would allow for teachers in the classroom, to not have to have a staff person sitting beside the student and providing tokens throughout the student's independent work time. That staff member, whether it be a paraeducator or the special education teacher, would be able to help other students within the classroom.

Implications for Practitioners

Although the QABF can be completed and scored in about 20 min (Matson et al., 2012), ours only took around 10 min to complete and be scored. This is the case because the special education teacher did not have to think long for her answers when the questions were asked to her. The COA assessment can last anywhere from 20-30 min, depending how many sessions are conducted, our COA took 20 min. The COA requires different sets of stimuli to be selected prior to running the assessment and required the student to miss out on instructional time from his classes. While the QABF requires only a copy of the QABF form, and the student is not required to be present. Based on the time, amount of resources necessary, and having to pull Max from his classroom I would conclude that for practitioners, the QABF would be easier to implement and to help guide you in developing an intervention.

For practitioners, the ease of implementation of the intervention conditions could be a benefit. Once you have an identified reinforcer, just write that reinforcer on the top of the worksheet they are working and give checkmarks at the end of the independent work session. This allows the student to receive at least some reinforcement time based on their responding. Once they learn the contingency you would hope that they would want to complete more work to receive more time with their reinforcer.

Limitations and Future Research

It should be noted the ecological validity of the COA sessions had some limitations due to using a novel adult (primary investigator) to provide attention within the assessment. We planned to have the special education teacher or the paraeducator that the student prefers to provide attention within the assessment, but during the time the resource classroom was free of other students, they were both unavailable. So, when

conducting COAs in the future, it might be best to find a time that at least one of the student's preferred people are available to provide attention during the session. This could possibly reduce the Hawthorne effect on the student from allocating their time to the choice area where attention is provided, just to be with the novel person that is providing attention.

We were able to get six COA-based reinforcer sessions, five QABF-based reinforcer sessions, but only four baseline sessions during the intervention comparison phase. This does not meet the recommended amount sessions of at least five sessions per condition (Ledford & Gast, 2018). When analyzing the two data points with a high-level during baseline data point in the intervention comparison condition, there could be a possible Hawthorne effect and the possibility for multi-treatment interference that is influencing the data. There would need to be more baseline data collected to assure that the threat of internal validity, multi-treatment interference, is not present. To help reduce the possibility of a Hawthorne effect in the future, researchers could interact with the participant more before implementing assessments and intervention sessions. This could look like the researcher assisting the participant in the classroom, having conversations with them, or being in the classroom more frequently or for a longer period of time. To sufficiently answer our fourth research question, we would want to continue conducting sessions until we conducted at least five baseline sessions within the intervention comparison condition. It should be noted that PI one, who was conducting the sessions, was a novel reinforcing adult in the classroom. For him to continue work to gain access attention from that adult would not be sustainable during a typical school day. For future research, the person providing attention within the COA should be someone that is

consistently in the classroom. That way if the student is working for attention from that adult, it is more sustainable than a researcher coming in.

A limitation within our study was that some of the procedures during baseline and intervention varied. During intervention we wrote the reinforcer on the top of the worksheet, while during baseline we did not write anything at the top of the worksheet. Also, during baseline conditions, there was a delay between when Max would receive feedback on his work. Unlike during intervention, Max received feedback immediately after his session on why his work was counted as complete; this could possibly influence his responding. This is a limitation because any change other than the change in reinforcers could serve as a confounding variable within the study. Also, another limitation would be the fact that we only had one participant in the study. The results from this study are specific to Max. So, there could be a possibility of these interventions only working with this student. Future research should try, if possible, to have more than one participant in it to show the effects of the interventions on work completion.

For future research, it could help to run some type of preference assessment (e.g., free-operant, multiple stimulus without replacement, etc.) to figure out the student's high preferred and low-preferred items. In our study, we were limited and only conducted teacher and student interviews to figure out Max's high and low-preferred items. Just using the interviews and no preference assessment data could lead to an inaccurate representation of the student's preferences. So, it could be possible that we did not have Max's most preferred items. In the future there should be more studies using COAs to identify potential reinforcers and evaluate the effects of an intervention derived from the COA results on student's work completion. Doing so will help to extend the external

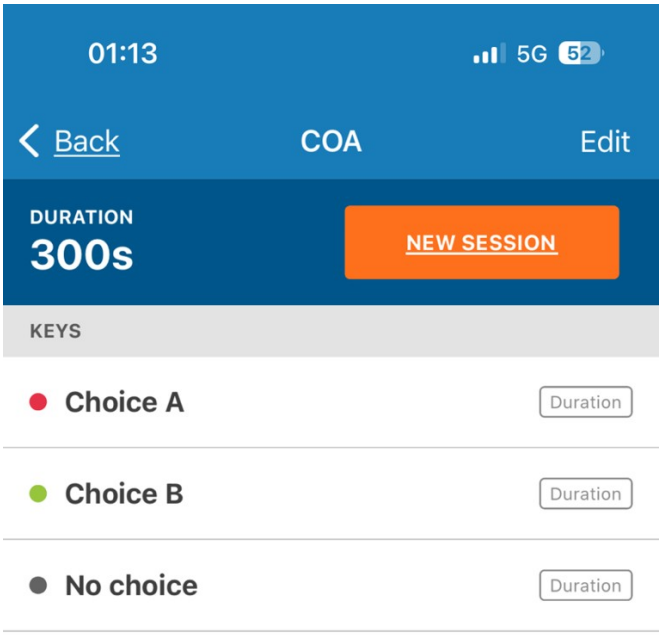
validity of the use of COAs in the classroom to increase work completion. As well as extending the literature about the effectiveness of COAs on work completion, future research should be conducted on the alignment between the results of the COA and indirect assessments (e.g., QABF, Motivation Assessment Scale, Functional Assessment Screening Tool).

CONCLUSION

Although, we were not able to see superiority between the intervention derived from the COA and the intervention derived from thee QABF, we were able to see differentiation between the two interventions compared to baseline. It should be noted that implementing some kind of intervention was more effective than keeping procedures the same during independent work time to increase percentage of work completion for Max.

APPENDICIES

APPENDIX A



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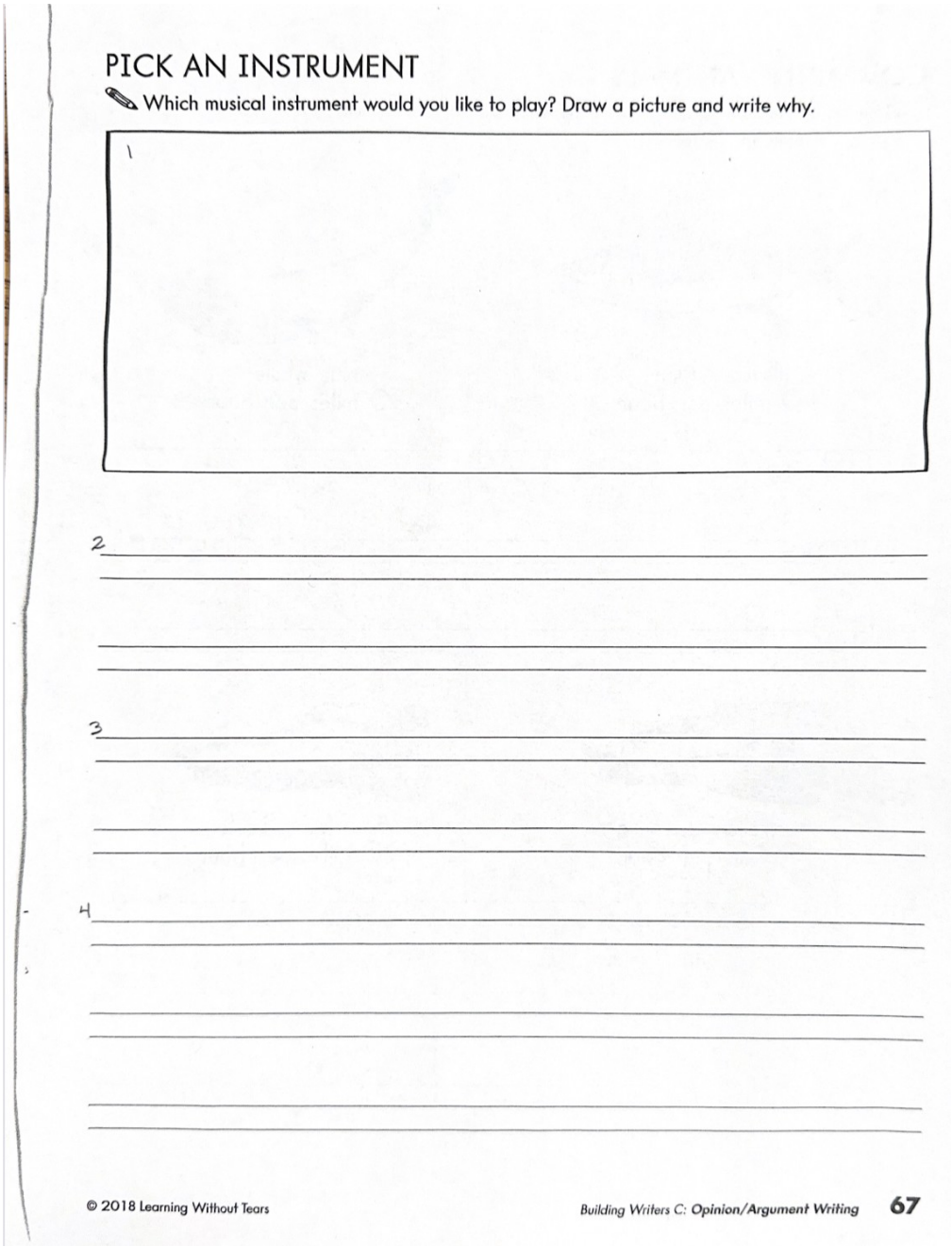
APPENDIX B



PICK AN INSTRUMENT

Which musical instrument would you like to play? Draw a picture and write why.

1

2

3

4

APPENDIX C

Concurrent Operant Analysis

Directions:

1. Record data on implementor's fidelity of the COA protocol (+) – Correct Independent (-) – Incorrect/prompted, (N/A)- Not applicable.
2. Provide behavior specific verbal praise for correct responses for each step of the protocol in-vivo (while parent is implementing protocol)

Mastery Criteria: Two consecutive sessions in which no corrective feedback is needed. "Session" should be defined prior to training, but typically will be the steps of the protocol currently being trained (you may need to have two separate treatment recommendation fidelity sheets if you are breaking the protocol into multiple components for training purposes)

	Steps of Protocol	**Condition Label**							
1	Countee App is ready								
2	Gather materials for condition (toys, demand materials, etc.)								
3	Set Condition								
4	Move student to the neutral space in between Choice A and Choice B								
5	Provides instructions to student "You can ____ in choice A or you can ____ in choice B. You are allowed to switch sides whenever you would like. Do you have any questions?"								
6	Answers questions if any are asked								
7	Provide statement to start the condition "Alright, make a choice"								
8	Start 5-minute timer and begin collecting data on the Countee App								
9	Provide verbal prompt once per condition "remember you can change your mind and go to the other choice at any point" on a VI-2 schedule.								
10	Once timer, goes off tell student that the condition has concluded and tell them to take break in the neutral area								
11	Analyze data and ensure 70% of the participants choice allocation was for one Choice area								
12	Review flowchart and determine next condition								
	Number Correct / Total # of Steps								
	% Correct								

APPENDIX D

Baseline1

Participant: (Max) **Data Collector: Kailee** **Implementor: Lane**

Directions:

1. Record data on implementor's fidelity of the baseline protocol (+) – Correct Independent (-) – Incorrect/prompted, (N/A)- Not applicable.

	Steps of Protocol	**Date + Session**							
1	Have materials ready (e.g., worksheet, pencil, 5-min timer)								
2	Tell Ja "It's time to work"								
3	If Ja is not at his desk ask him to move to his desk								
4	Provide the direction "It's time to start working, you are working for a 5-min break. You can do as much or as little of the worksheet as you want)								
5	Start 5-min timer								
6	If Ja asks a content related question you are able to engage								
7	If Ja has any bids for attention (e.g., starting unrelate conversation, laying head down, whining, etc.) ignore the behaviors								
8	Once the 5-min timer is up, tell Ja he is done working and collect the worksheet								
9	Tell Ja he has accessed a 5-min break and start his timer								
10	Score the permanent product for work completion (divide the # of questions completed/ total # of questions)								
	Number Correct / Total # of Steps								
	% Correct								

APPENDIX E

Baseline 2

Participant: Max (pseudonym) **Data Collector: Kailee** **Implementor: Lane**

Directions:

1. Record data on implementor's fidelity of the baseline protocol (+) – Correct Independent (-) – Incorrect/prompted, (N/A)- Not applicable.

	Steps of Protocol	**Date + Session**							
1	Have materials ready (e.g., worksheet, pencil, 5-min timer)								
2	Tell Max it's time to work								
3	If Max is not at his desk ask him to move to his desk								
4	Provide checkmarks and feedback from last sessions worksheet								
5	Set session by providing and explaining the worksheet expectation (e.g., how many questions there are, writing in complete sentences, how many reasons he has to give, etc.)								
6	Provide the direction "It's time to start working, you are working for a 5-min break where you can just relax. You can do as much or as little of the worksheet as you want"								
7	Do you have any questions? If so, answer questions.								
8	Start 5-min timer								
9	If Max asks a content related question during the session you are able to engage								
10	If Max has any bids for attention (e.g., starting unrelate conversation, laying head down, whining, etc.) ignore the behaviors								
11	Once the 5-min timer is up or Max has completed the whole sheet, tell Max he is done working and collect the worksheet								
12	Tell Max he has accessed a 5-min break and start his timer								
13	Score the permanent product for work completion (divide the # of questions completed/ total # of questions)								
14	Start Timer for Break								
15	Tell Max his break is over when the timer goes off								
	Number Correct / Total # of Steps								
	% Correct								

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