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Functional Living Skills and Adolescents and Adults with Autism Spectrum Disorder: A Meta-Analysis

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Abstract: Functional living skills are skills needed for being an independent individual in society. As individuals with autism spectrum disorder (ASD) get older, the discrepancy between functional living skills of themselves and their peers increases. However, it is not known which type of intervention is more or less effective specifically for adolescent- and adult-aged persons with ASD. This systematic review and meta-analysis analyzed peer-reviewed research concerning functional living skills for individuals with ASD. Using the Tau-U effect size analysis, the following categories were analyzed: participant diagnoses, independent variables, and dependent variables. In addition, to identify statistically significant differences based on categories of the evaluated variables, we conducted the Kruskal-Wallis analysis and a Dunn post-hoc test. A total of 32 single-case studies were included in this analysis. Results indicated that interventions to improve functional living skills with adolescent- and adult-aged persons with ASD had overall strong effects. Moderate to strong effects were noted across categories for diagnosis. Findings indicated strong effects across categories for dependent and independent variables. Limitations and implications for practice and future research were discussed.

Autism spectrum disorder (ASD) is a life-long developmental disability that affects an estimated 1 in 68 children in the United States (Centers for Disease Control and Prevention [CDC], 2014). However, this statistic is not just limited to the United States; similar increases in ASD prevalence have been reported worldwide (see Bölte, Poustka, & Holtmann, 2008; Honda, Shimizu, & Rutter, 2005; Sun & Allison, 2010). Core characteristics of ASD include deficits in communication and social interactions, as well as the presence of stereotypic and repetitive behaviors (American Psychiatric Association [APA], 2013). In addition, autism is often correlated with cognitive deficits and delays in adaptive functioning (Volkmar, Sparrow, Goudreau, & Cicchetti, 1987). Given deficits in several skill domains, adolescents and adults with ASD often experience negative outcomes, such as low rates of employment and low social involvement, compared to those without autism (Howlin, Goode, Hutton, & Rutter, 2004).

Functional living skills are defined as skills needed for being an independent individual in society (Sparrow, Cicchetti, & Balla, 2005). As individuals with ASD get older, the discrepancy between the functional living skills of

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themselves and their peers increases (Carter et al., 1998). Given the lack of these skills, individuals with ASD often tend to be dependent on their families or related services when they reach adulthood, resulting in an increased burden of care for their families or service providers (Howlin et al., 2004). For example, Shattuck and colleagues (2012) found that approximately 80% of young adults with ASD lived at home, and among those individuals, only 6% had paid jobs after graduating from public schools. With the growing number of individuals with ASD who transition into adulthood and employment, more attention has recently been given to understanding and treating adolescent- and adult-aged persons with ASD (Cimera & Cowan, 2009); however, there remains a dearth of research on promoting the independent living of those individuals (Shattuck et al., 2012).

To improve functional living skills of individuals with ASD, researchers have examined various types of instructional approaches (e.g., prompting, reinforcement, modeling) and found them to be effective in promoting those skills (Bennett & Dukes, 2014; Walsh et al., 2014). Ninci and colleagues (2015) found that there are four types of interventional approaches that have been most utilized to improve functional living skills of individuals with ASD. Those approaches include video modeling, behavioral in-vivo procedures, audio cueing, and visual cues (Ninci et al., 2015). Moderate to strong effects were found for the four intervention techniques. Although those types of strategies were found to be effective in improving functional living skills of individuals with ASD, it is not known which type of intervention is more or less effective specifically for adolescent- and adult-aged persons with ASD because prior work was not limited to this age range.

A recent meta-analytic review (Ninci et al., 2015) indicated that most studies that investigated within-person changes in functional living skills for individuals with ASD have focused on adolescent- and adult-aged persons. Additionally, adolescent- and adult-aged participants with ASD showed strong effects compared to the preschool- and secondary-aged participants with ASD. However, it is unknown why those older participants show relatively stronger improvements in targeted functional living skills. Many researchers have investigated how IQ affects acquisition of functional living skills in individuals with ASD. These studies have found that children with ASD who had higher IQs showed better acquisition of targeted skills than children who had lower IQs, indicating that the presence of an intellectual disability may slow the skill acquisition rate (Freeman, Del'Homme, Guthrie, & Zhang, 1999; Green & Carter, 2011). Although previous studies have suggested that cognitive functioning levels may differentially affect the rate of growth among individuals with ASD, most of the studies examined its relation with early-aged individuals, leading to difficulties generalizing their findings to older individuals with ASD.

In addition to clarifying under what circumstances each intervention is effective for adolescents and adults with ASD, an evaluation of outcome variables that the intervention strategy can be expected to have a positive impact on is also needed (Horner et al., 2005). In addition, it is necessary to assess the efficacy of the intervention strategy for particular functional living skills in order to assist practitioners in choosing the most appropriate functional living skill intervention. Four functional living skills have often been targeted as outcome variables in the research literature, including self-help skills, household chores, employment skills, and skills related to accessing the community (see Ninci et al., 2015); however, no previous analyses have evaluated whether older individuals with ASD show better acquisition of a particular functional living skill compared to others, leading to difficulties for practitioners who wish to select an appropriate target behavior for this population.

Recent legislative mandates in the U.S., including the Individuals with Disabilities Education Act (IDEA) of 2004, require educators to use scientifically validated practices, also called evidence-based practices (EBPs; Horner et al., 2004). Because single-case research is the primary design methodology used for individuals with low-incidence disabilities, such as ASD and significant developmental delay, this methodology is considered appropriate for establishing EBPs with this population (Horner et al., 2004). However, single-case studies often use a variety of research designs and outcome measures, making it challenging to aggregate and analyze data from those studies (Ganz et al., 2011). To help identify EBPs, meta-analytic techniques have been used to synthesize and analyze data from different single-case studies using a single statistic metric (Banda & Therrien, 2008).

Tau-U, a non-parametric effect size measure, has been considered the most appropriate statistical analysis for single-case research because it addresses several issues related to previously used non-overlap statistical analyses (Parker, Vannest, Davis, & Sauber, 2011b). First, Tau-U offers greater statistical power and precision than other nonoverlap statistic options (Parker et al. 2011b). Second, Tau-U is robust to autocorrelation of data; therefore, Tau-U does not vary in response to a level of autocorrelation of data (Parker et al., 2011b). Third, Tau-U has a function of controlling an undesirable baseline trend (Parker et al., 2011b). Fourth, as a top-down approach, Tau-U can be calculated with only a few data points and phases in the design (Parker & Vannest, 2012). In addition, Tau-U has been found to be consistent with visual analysis of data in a design (Brossart, Vannest, Davis, & Patience, 2014; Parker et al., 2011b). Tau-U has increasingly been used in single-case research studies (Ganz et al., 2013; Hong, Ganz, Gilliland, & Ninci, 2014) and meta-analytic reviews of single-case research (Bowman-Perrott et al., 2013; Ninci et al., 2015).

This meta-analysis aimed to determine the magnitudes of effect of educational interventions for teaching functional living skills to adolescent- and adult-aged individuals with ASD, differentiated by the following potential variables: (a) independent variables, (b) participant diagnoses, and (c) dependent variables. In addition, we investigated whether any statistically significant differences existed within levels or categories of the evaluated variables.

Research Questions

1. What are the magnitudes of effect (i.e., Tau-U effect sizes) of educational interventions for teaching functional living skills to people with ASD, differentiated by the following variables: (a) independent variables, (b) participant diagnoses, and (c) dependent variables?
2. Are there any statistically significant differences within levels or categories of the evaluated variables?

Method

A subset of the articles identified by Ninci et al. (2015) were also included in this review and the search and inclusion/exclusion procedures herein reflect those conducted in the prior meta-analysis. In the review by Ninci et al. (2015), studies that evaluated effects of educational interventions on improving functional living skills of all aged-individuals with ASD were included, while this review targets studies that included young adolescent- and adult-aged individuals with ASD. The studies selected for inclusion in the current meta-analysis were identified following all inclusion and exclusion procedures for Ninci et al. (2015). The search and inclusion/exclusion procedures for Ninci et al. (2015) are summarized below for the readers' information.

Article Identification

To identify studies to include in the prior review, the following electronic databases were searched: *ERIC, Academic Search Complete, Professional Development Collection, Social Sciences Full Text*, and *PsycINFO*. Only peer-reviewed journal articles were included in this review. Publication year was not restricted. If an article did not have an author or was not a peer-reviewed article, the article was excluded. This resulted in a total of 1761 articles that were reviewed to determine whether they met the inclusion criteria.

Inclusion and exclusion criteria. To be included in the review, an article had to meet the following inclusion criteria: (a) included at least one participant with ASD (i.e., the participant was described as having a pervasive developmental disorder, Asperger syndrome, ASD or "autism," or an "autistic" behavior); (b) used a single-case research design (e.g., multiple-baseline design, multiple-probe design, alternating treatment design, reversal or withdrawal designs, or a combination of more than one of those designs); (c) presented data in a line graph with individual data points; (d) included at least one dependent variable that targeted an independent adaptive or functional living skill of an individual with ASD (e.g., house-keeping tasks, employment, transportation use, cooking, hygiene and personal care, shopping, accessing public setting, banking and money management, self-feeding, and toileting initiations); (e) included a type of educational intervention as the independent variable; and (f) was published in English. Studies were excluded if any of the following exclusion criteria were met: (a) dependent variable targeted social, play, communication, or leisure skills, (b) data on the participants' behavior were not separated from the implementer's behavior (e.g., level of prompt provided); or (c) used any type of pharmacological treatments.

As a result of the initial screening, a total of 44 studies met the initial inclusion criteria. To identify additional articles that might meet the inclusion criteria, an ancestral search was conducted, resulting in 28 studies. Therefore, a total of 71 articles were identified for further evaluation. Among the 72 articles, 32 articles included young adolescent- or adult-aged persons with ASD and were evaluated for further analysis in the current meta-analysis.

Inter-rater reliability on inclusion and exclusion criteria. To determine whether the study met the initial inclusion criteria for the Ninci et al. (2015) meta-analysis, two independent coders evaluated a total of 881 of the 1761 articles (50%). A percentage of agreement was used to calculate an inter-rater reliability (IRR) score throughout the study. IRR was calculated by dividing agreements between coders by agreements plus disagreements and multiplying by 100. The obtained IRR on the initial inclusion criteria was 97%. Any disagreements between the coders were discussed until they came to consensus or a third coder reviewed the disagreements and made the final decision.

Application of the basic design standards. Following initial inclusion/exclusion procedures, each article was reviewed to determine whether or not it met the basic design standards developed by the What Works Clearinghouse (WWC; Kratochwill et al., 2010), adapted by Maggin, Briesch, and Chafouleas (2013). From here forward, the procedures described only apply to the 32 studies from the original meta-analysis that included adolescent- and adult-aged participants. Because studies that did not meet the basic standards were excluded by Ninci et al. (2015) prior to selection for the current meta-analysis, none of the 32 studies reviewed for the current meta-analysis did not meet the basic design standards.

Inter-rater reliability on design standards. Two independent coders reviewed the 32 articles (100%), as a component of the larger meta-analysis (Ninci et al., 2015), to determine whether each of the studies met the design standards, met them with reservations, or did not meet the design standards. Averaged across the six design standards, the IOA was 88%.

Variable Coding

For the purposes of this meta-analysis, the 32 studies that either met the design standards or met them with reservations were summarized based on the following variables: independent variable, participant diagnosis, and dependent variable. If a study variable did not fit in the classified categories or did not provide descriptions regarding these variables, the study variable was coded as "OTHERS." For each moderator, anything categorized as "OTHERS" was excluded from further analysis due to the heterogeneity of that category.

The independent variable was divided into four levels, determined by the following criteria: (a) if a study used a type of video modeling, the intervention variable was coded as "VM"; (b) if a study used a type of audio cueing defined as that an instructor provided verbal instructions to the participant, the intervention variable was coded as "AC"; (c) if a study used a type of behavioral in-vivo instruction, including reinforcement, prompting, and prompt fading, the intervention variable was coded as "BIV"; and (d) if a study used a type of visual cue, including schedules, pictorial task analysis, and social stories, the independent variable was coded as "VC." Studies that used video modeling, audio cueing, or visual cues often tended to use a type of behavioral in-vivo techniques. Therefore, if a study used video modeling, audio cueing, or visual cues in combination with behavioral in-vivo techniques, the intervention variable was coded as the former (i.e., video modeling, audio cueing, visual cues).

The participant's diagnosis was coded for the following variables: (a) if a study reported that the participant had autism spectrum disorder or autism, the participant's diagnosis variable was coded as "AU"; (b) if a study reported that the participant had high-functioning autism or Asperger Syndrome, the participant's diagnosis variable was coded as "HFAAS"; and (c) if a study reported that the participant had autism with a comorbid diagnosis of intellectual disability (i.e., the participant's IQ was below 70) or if the participant's adaptive behavior scores were two or more years delayed compared to the age equivalent score, the participant's diagnosis variable was coded as "AUIDD."

The dependent variable included the following four levels: (a) if a study targeted self-help skills, such as toileting, cooking, hygiene, bathing, tooth-brushing, dressing, and independent eating, the outcome variable was coded as "SH"; (b) if a study measured house chore related skills, including cleaning and laundry, the outcome variable was coded as "HC"; (c) if a study targeted any employment skills, the outcome variable was coded as "ES"; and (d) if a study measured community access skills, such as transportation use, banking, and shopping, the outcome variable was coded as "COMMACC."

Inter-rater reliability on variable coding. Variables were coded as a component of the prior meta-analysis (Ninci et al., 2015); however, to increase the proportion coded by two raters, additional articles were coded for the current review. Two independent coders reviewed a total of 16 studies (50%) to establish IRR for the four variable categories. The obtained IRR was 94%, ranging from 80 to 100% by variable.

Data Extraction and Analysis

To calculate effect sizes, data were extracted from each graph in each study included in this review. In the event that data measured behaviors of the participants who did not have ASD, or behaviors other than functional living skills, these data were excluded from the analysis. Graphs that did not meet the basic design standards were also excluded from further data analysis. Two adjacent phases were contrasted at a time (e.g., A_1 vs. B_1, A_2 vs. B_2; Parker et al., 2010b). A rank-order technique was used to extract data from each graph (Parker, Vannest, & Davis, 2011a). A data point plotted at the lowest point across the adjacent phases was ranked number 1. A data point plotted at the second lowest point across the adjacent phases was ranked number 2. This iterative process was continued until a data point plotted at the highest point across the phases was ranked. In the event that two or more data points were tied or plotted at the same point, the same rank number was assigned to those data points. If a study targeted a behavior intended to decrease, data were ranked in reverse order.

Inter-rater reliability for data extraction. Data were extracted as a component of the prior meta-analysis (Ninci et al., 2015). To increase the proportion coded by two raters, additional data were extracted for the current review. The second independent coder extracted a total of 869 data points from each graph across 13 studies (40%). IRR was calculated using a point-to-point percentage of agreement to determine correspondence of point-to-point data points across phases. The obtained IRR was 88.2%, ranging from 50 to 100% by experimental design.

Effect size calculation. A non-parametric Tau-U effect size (Parker et al., 2011b) was used to calculate effect sizes. In this review, Tau software developed through the Maple platform was used to calculate an individual effect size for each phase contrast, as well as an omnibus effect size (Davis & Davis, 2014). Tau-U scores ranged from −1.0 to 1.0. If Tau-U scores were larger than 0.0, it indicated improvement between the two phases. If Tau-U scores were smaller than 0.0, it indicated that there was a deteriorating data set between the phases. Tau-U scores can be interpreted as following: (1) if Tau-U score ranges from 0 to .62, it indicates a small effect; (2) if Tau-U score ranges from .63 to .92, it indicates a moderate effect; and (3) if Tau-U score ranges from .93 to 1.00, it indicates a large effect (Parker et al., 2011a).

After the Tau calculation, the Kruskal-Wallis one-way analysis of variance was calculated as an omnibus test to determine if there were any differences in the group distributions (Kruskal & Wallis, 1952). The Kruskal-Wallis is a nonparametric analysis that is typically used to evaluate group differences when data do not meet standard ANOVA assumptions of normality (Elliott, & Hynan, 2011), as is often

TABLE 1

Number of Studies, Participants, Analyses, and Tau Results

Independent Variable	*Number of Studies*	*Number of Study Participants*	*Number of Contrasts*	*Group Tau [CI$_{95}$]*
Independent variable				
Audio cueing	6	11	18	.940 [.828, 1.000]
Video modeling	16	46	83	.890 [.838, 942]
Behavioral in-vivo	7	23	38	.917 [.851, .984]
Visual cues	3	8	10	1.000 [.826, 1.000]
Diagnosis				
Autism and either mental retardation or intellectual disability	25	60	120	0.922 [.879, .965]
ASD or autism	9	17	23	0.918 [.818, 1.000]
Cognitively high-functioning autism or Asperger syndrome	3	5	9	0.724 [.586, 1.000]
Dependent variable				
Employment skills	18	50	82	.906 [.855, .957]
Self-help skills	6	15	34	1.000 [.905, 1.000]
House chores	5	16	26	.851 [.757, .945]
Community access skills	5	10	19	.929 [.841, 1.000]

the case with single-case data. If a statistically significant difference was found for any of the variables, a Dunn post-hoc test was planned to evaluate the pair-wise combinations (Dunn, 1964).

Additional analysis on video modeling. In order to determine the circumstances and participants for whom functional living skills are most effective, we conducted analyses to determine effect sizes for four independent variables, three participant diagnoses, and four dependent variables; however, we also conducted an additional analysis so we could draw more fine grained conclusions regarding for whom and for what specific dependent variables each intervention is most effective. Because half of the studies ($N = 16$) evaluated in this review used video modeling as an interventional technique, an additional analysis was conducted to identify how the effects of video modeling were differentiated by participant diagnosis and the dependent variable. Additional analyses were not conducted on other independent variables identified in this meta-analysis (i.e., audio cueing, behavioral in-vivo instruction, and visual cues) due to the small number of studies that have used these interventions to teach functional living skills to adolescent- and adult-aged participants with ASD.

Results

Data from this study yielded 162 separate AB contrasts from 32 unique studies with 86 participants. Within all experiments analyzed, a wide range of Tau-U effect sizes were identified (i.e., .372 to 1.000), while a majority of studies resulted in moderate effects or strong effects (i.e., .724–1.000). In addition to the overall effect sizes across the experiments, analyses for variables were conducted.

Independent Variable

Analysis of the independent variable had four unique variables (see Table 1). In order to generate an effect size for each category, the following contrasts were analyzed: in the audio cueing (AC) category, 18 contrasts across 6 studies were evaluated; in the video modeling (VM) category, 83 contrasts across 16 studies were evaluated; in the behavioral in-vivo (BIV) category, 38 contrasts across 7 studies were evaluated; and in the visual cues (VC) category, 10 contrasts across 3 studies were evaluated. Within this analysis, Tau-U effect sizes ranged from a moderate effect of .890 CI$_{95}$ [.838, 942] for video modeling to a strong effect of 1.000 CI$_{95}$ [.826, 1.000] for visual cues. The Krukal-Wallis showed no sta-

TABLE 2

Additional Analysis Using Video Modeling Only-Number of Studies, Participants, Analyses and Tau Results

	Number of Studies	*Number of Study Participants*	*Number of Contrasts*	*Group Tau [CI_{95}]*
Diagnosis				
Autism and either mental retardation or intellectual disability	13	35	63	0.911 [.848, .974]
ASD or autism	5	6	10	0.893 [.756, 1.000]
Cognitively high-functioning autism or Asperger syndrome	1	4	8	0.780 [.632, .929]
Dependent variables				
Employment skills	7	22	40	.891 [.820, .963]
Self-help skills	4	11	13	1.000 [.852, 1.000]
House chores	5	16	26	.851 [.757, .945]
Community access skills	2	2	3	.720 [.355, 1.000]

tistically significant differences between studies based on the independent variable categorization ($p = .044$).

Participant Diagnosis

Three unique variables were categorized within the diagnosis category (see Table 1). The following contrasts were analyzed in order to generate an effect size for each category: in the autism and intellectual disability (AUIDD) category, 120 contrasts across 25 studies were evaluated; in the ASD or autism (AU) category, 23 contrasts across 9 studies were evaluated; and in the cognitively high-functioning autism or Asperger syndrome (HFAAS) category, 9 contrasts across 3 studies were evaluated. Within this analysis, Tau-U effect sizes ranged from a moderate effect of 0.724 CI_{95} [.586, 1.000] for a diagnosis categorized as cognitively high-functioning autism or Asperger syndrome to a strong effect of 0.922 CI_{95} [.879, .965] for a diagnosis categorized as autism and intellectual disability. The Kruskal-Wallis analysis indicated no statistically significant differences between studies based on diagnostic categorization ($p = .656$).

Additional analysis on video modeling: Participant diagnosis. For the additional analyses using video modeling only, three unique variables were categorized within the diagnosis category (see Table 2). In order to generate an effect size for video modeling as differentiated by participant diagnosis, the following contrasts were analyzed: in the autism and intellectual disability (AUIDD) category, 63 contrasts across 13 studies were evaluated; in the ASD or autism (AU) category, 10 contrasts across 5 studies were evaluated; and in the cognitively high-functioning autism or Asperger syndrome (HFAAS) category, 8 contrasts in 1 study were evaluated. Within this analysis, Tau-U effect sizes ranged from 0.780 CI_{95} [.632, .926] for a diagnosis categorized as cognitively high-functioning autism or Asperger syndrome to 0.911 CI_{95} [.848, .974] for a diagnosis categorized as autism and intellectual disability, indicating moderate effects were found for each of the three of the participant diagnosis categories. The Kruskal-Wallis analysis indicated no statistically significant differences between studies based on diagnostic categorization ($p = .749$).

Dependent Variable

Within the dependent variable category, four unique variables were categorized (see Table 1). The following contrasts were analyzed in order to generate an effect size for each category: in employment skills (ES) category, 82 contrasts across 18 studies were evaluated; in the self-help skills (SH) category, 34 contrasts across 6 studies were evaluated; in the hose chores (HC) category, 26 contrasts across 5 studies were evaluated; and in the community access skills (COMMACC) category, 19 contrasts across 5 studies were evaluated. Within

TABLE 3

Additional Analysis-Group Comparisons in Average Ranks, Alpha, and Significance Difference: Dunn Post-hoc Test for Dependent Variable

Group Comparisons	*Difference in Average Ranks*	*Cutoff at Alpha = 0.05*	*Significance Difference*
Community access skills-Employment skills	33.3542	37.6111	
Community access skills-Self-help skills	44.1667	40.2439	**
Community access skills-House chores	28.0513	38.3111	
Employment skills- House chores	5.3029	15.8281	
Employment skills- Self-help skills	10.8125	20.0590	
House chores- Self-help skills	16.1154	21.3426	

this analysis, Tau-U effect sizes ranged from a moderate effect of .851 CI_{95} [.757, .945] for a dependent variable categorized as house chores to a strong effect of 1.000 CI_{95} [.905, 1.000] for a dependent variable categorized as self-help skills, indicating that strong effects were found for each of the four dependent variable categories. The Krukal-Wallis indicated statistically significant differences between studies based on the dependent variable categorization ($p < 0.01$).

Additional analysis on video modeling: Dependent variable. For the additional analysis using video modeling only, four unique variables were categorized within the diagnosis category (see Table 2). In order to generate an effect size for each category, the following contrasts were analyzed: in the employment skills (ES) category, a total of 40 contrasts across 7 studies were evaluated; in the self-help skills (SH) category, a total of 13 contrasts across 4 studies were evaluated; in the house chores (HC) category, a total of 26 contrasts across 5 studies were evaluated; and in the community access skills (COMMACC) category, 3 contrasts across 2 studies were evaluated. As a result of these analyses, Tau-U effect sizes ranged from a moderate effect of 0.720 CI_{95} [.355, 1.000] for the community access skills category, to a strong effect of 1.000 CI_{95} [.852, 1.000] for the self-help skills category. The Kruskal-Wallis analysis indicated statistically significant differences between dependent variables ($p < 0.01$). As a result he Dunn post-hoc procedure was conducted and results indicated a statistically significant difference between the self-help skills category and the community access skills category (see Table 3).

Discussion

The purpose of this meta-analysis was to investigate the magnitudes of effect of educational interventions for teaching functional living skills to adolescent- and adult-aged individuals with ASD. Specifically, we investigated the following moderators: (a) participant diagnoses, (b) independent variables, and (c) dependent variables. In addition, we also conducted an additional analysis with studies that used video modeling as an intervention in order to identify how the effects of video modeling were differentiated by participant diagnosis and the dependent variable. Additional analyses were not conducted with audio cueing, behavioral in-vivo instruction, or visual cues due to the paucity of research that has been conducted using these interventions to teach functional living skills to adults and adolescents with ASD. Lastly, we investigated whether there were any statistically significant differences between levels or categories of these moderators. Although researchers have recently begun to focus on the best way to treat adolescent- and adult-aged individuals with ASD (Cimera & Cowan, 2009), it is still unclear how to best foster the independent living skills in this population. Ninci and colleagues (2015) recently conducted a meta-analysis on functional living skills in individuals with ASD; however, because they did not focus on adolescent-and adult-aged individuals, questions still remained. This meta-analysis contributes to the literature base by answering questions about which educational interventions are most effective for teaching functional living skills to adolescent- and adult-aged individuals with ASD.

The first variable that was investigated was the independent variable, or the type of educational intervention used to teach functional living skills. Specifically, this study explored the following four independent variables: audio cueing, video modeling, behavioral in-vivo, and visual cues. Strong effects were found for all four independent variables, indicating that they are all effective for teaching functional living skills to adolescent- and adult-age individuals with ASD. However, because three of the interventions (i.e., audio cueing, visual cues, and behavioral in-vivo interventions) included seven or fewer studies, these results should be viewed with caution. Video modeling included the most studies, which suggests that there is a strong research base to support its use with adolescents and adults with ASD to teach functional living skills.

The second variable that was evaluated was participant diagnoses. While Tau-U analyses showed moderate to strong effects for all three diagnoses, the strongest effects were found for individuals with autism and intellectual disability and for individuals with ASD or autism. One possible reason that individuals with cognitively high-functioning autism or Asperger syndrome did not show as strong effects as those with the two aforementioned diagnoses could be the limited number of studies conducted with this population. This is not surprising given that adaptive behavior functioning has a strong negative correlation with autism symptomatology (Kenworthy, Case, Harms, Martin, & Wallace, 2010); in other words, individuals with high-functioning autism often have strong adaptive behavior, or functional living skills.

In order to gain further insight into the population for whom video modeling is most effective, we conducted an additional analysis using only studies that used video modeling as an intervention. The results of this analysis demonstrated moderate effects for all three participant diagnoses; however, the strongest effect was found for autism and intellectual disability. This indicates that video modeling is a viable intervention to teach functional living skills to adults and adolescents diagnosed with autism and a comorbid intellectual disability. Considering the moderately large number of studies ($N = 13$) and participants ($N = 35$) used in the analysis to calculate the effect size for individuals with autism and intellectual disability, readers can be fairly confident in the reliability of these results. However, the other two diagnoses, ASD or autism and cognitively high-functioning autism or Asperger syndrome, included a very limited number of studies and participants. As a result, the effects found for these two diagnoses should be interpreted with caution.

The third moderator that we investigated was the dependent variable in the study, or the type of functional living skill that was taught. This meta-analysis explored the following four dependent variables: employment skills, self-help skills, house chores, and community access skills. All four dependent variables showed strong effects, indicating that these are all skills that can be successfully taught to individuals with ASD. Out of the four dependent variables, employments skills was the skill most often investigated. This is expected, given that adolescent- and adult-age individuals were investigated in this meta-analysis. Considering that individuals with ASD are at a high risk for unemployment (Shattuck et al., 2012), it is encouraging that researchers are teaching employment skills and that the interventions are shown to be effective.

In order to gain a better understanding of the effects of specific interventions on the four functional living skills identified in this meta-analysis, we conducted an additional analysis on the dependent variables using only studies that used video modeling as the independent variable. The results of this analysis indicated that video modeling is moderately effective for teaching employment skills, house chores, and community access skills to adolescents and adults with ASD and strongly effective for teaching self-help skills to this population. Considering the ease with which video modeling can be implemented by practitioners (Carnahan, Basham, Christman, & Hollingshead, 2012), it is encouraging that the results demonstrated it is an effective intervention for teaching functional living skills to adults and adolescents with autism. It should be noted, however, that the community access skills category included a very small number of studies and therefore, the results should be interpreted with caution.

As is the case with most meta-analytical research, this study does include some limitations. First, as was the case in previous work (Ninci et al., 2015), we did not analyze data on generalization or maintenance conditions. This leaves questions as to whether the effects found for each of the interventions, particularly video modeling, will continue over time. Another limitation is the inclusion of only published studies. Because published studies typically include positive results, meta-analyses consisting of only published studies may result in biased conclusions (Duval & Tweedie, 2000). The results of this meta-analysis, therefore, should be interpreted with caution. Finally, while statistical analyses are the preferred method for evaluating single-case research and contribute to the identification of evidenced-based practices, they do not provide information regarding the context in which the data were collected (Brossart et al., 2014). Thus, readers are encouraged to consider the context in which the data were collected for the individual studies included in this meta-analysis when interpreting the statistical analyses presented.

This study also identifies several areas that need additional research. It would be beneficial to analyze data on generalization and maintenance conditions in future meta-analyses in order to determine long-term effects. Visual cues and audio cueing should also be investigated in future research to determine if this intervention will continue to show strong effects when investigated with additional participants. Finally, while employment skills was investigated in a number of studies (more than all of the other functional living skills combined), there remains a paucity of research on self-help skills, house chores, and skills related to accessing the community. Future research should focus on interventions designed to increase these skills among adolescent- and adult-aged individuals with ASD.

In conclusion, this meta-analysis contributes to the literature base by investigating the magnitudes of effect of four educational interventions on teaching functional living skills to adolescents and adults with ASD. In addition, this meta-analysis also answered questions about the effects of using video modeling to teach functional living skills to this population. Despite some limitations, this study has provided evidence to demonstrate that functional living skills can be effectively taught to adolescents and adults with autism using educational interventions. This is encouraging as it provides evidence that the skill deficits often experienced by adolescents and adults with autism can be remediated, which may lead to more positive outcomes for this population.

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