Title

Piloting a Novel Daily Living Skills Assessment in Autistic Adolescents and Young Adults

Journal

Autism in Adulthood, 5(1)

ISSN

2573-9581

Authors

Wulff, Rachel A

Iosif, Ana-Maria

Krug, Marie K

et al.

Publication Date

2023-03-01

DOI

10.1089/aut.2021.0095

Peer reviewed

AUTISM IN ADULTHOOD
Volume 5, Number 1, 2023

DOI: 10.1089/aut.2021.0095

Brief Research Report

Open camera or QR reader and scan code to access this article and other resources online.

Piloting a Novel Daily Living Skills Assessment in Autistic Adolescents and Young Adults

Rachel A. Wulff,[1] Ana-Maria Iosif,[2] Marie K. Krug,[1] Philip D. Harvey,[3] and Marjorie Solomon[1]

Abstract

Background: There are a few ecologically valid measurements of Daily Living Skills (DLS)—a critical component of adaptive functioning (AF)—for autistic adolescents and young adults. This is particularly important given that DLS predict outcomes as autistic adolescents transition to adulthood.
Methods: We pilot-tested the assessment section of two modules of the Computerized Functional Skills Assessment and Training program (CFSAT) in 25 autistic ($n=4$ female) and 25 non-autistic ($n=6$ female) adolescents and young adults to evaluate preliminary feasibility in an autistic sample. Tasks involved using an ATM and ticket-buying machine. We also assessed AF and DLS with a well-validated self-report questionnaire. We examined group differences in performance and relationships between performance on CFSAT and an existing measure of AF and DLS. We also conducted regression analyses to investigate the associations between age, IQ, executive functioning (EF), and CFSAT task performance.
Results: All but one autistic participant were able to complete the CFSAT tasks. Autistic participants made more errors, but did not take longer to complete the task, than non-autistic participants. Performance correlated strongly with self-reported AF generally and DLS specifically. The regression analyses revealed that task performance was associated with EF in the autistic group, but not the non-autistic group.
Conclusions: These results provide preliminary support for the use of a new performance-based ecologically valid assessment of DLS in an autistic population. Two CFSAT modules were well-tolerated and detected differences in DLS ability. Strong correlations with an existing measure of AF suggest evidence of construct validity. The EF was associated with CFSAT task performance in autistic individuals. Such a tool could help identify individuals who would benefit from a DLS intervention.

Keywords: adaptive functioning, computerized cognitive training, cognition, daily living skills

Community Brief

Why is this an important issue?

For autistic adolescents and young adults, one of the most important predictors of success after high school are daily living skills (DLS), which are a component of adaptive functioning (AF), or the ability to operate independently when engaged in day-to-day tasks. However, most of the measures used to assess these abilities are parent- or child-report questionnaires, which may lack objectivity.

What was the purpose of this study?

The Computerized Functional Skills Assessment and Training program (CFSAT) is an innovative software program that was designed to teach people how to perform daily tasks that require the use of technology. This

[1]Department of Psychiatry, MIND Institute, University of California, Davis. Sacramento, California, USA.
[2]Department of Public Health Sciences, University of California, Davis. Sacramento, California, USA.
[3]Department of Psychiatry and Behavioral Sciences, Miller School of Medicine, University of Miami, Miami, Florida, USA.

study piloted two CFSAT modules in a sample of autistic adolescents and young adults. The researchers wanted to see whether the program could be completed by the autistic participants and whether their performance related to an existing measure of DLS and other cognitive measures known to be related to AF.

What did the researchers do?

This study piloted the assessment portion of two CFSAT modules in 25 autistic and 25 non-autistic adolescents and young adults to investigate whether it might be a useful measure of DLS skills in autistic individuals. The assessment portion of the program gives participants tasks to complete on a virtual ATM and Metro Ticket Kiosk and records time to completion and accuracy. Participants also used a questionnaire to self-report DLS and general AF and performed cognitive tasks.

What were the results of the study?

All but one autistic participant were able to complete both tasks. The autistic group made more errors but did not take more time to complete the tasks compared with the non-autistic group. Performance on the CFSAT was related to self-reported DLS scores on a questionnaire and to scores on cognitive tasks.

What do these findings add to what was already known?

Previous work recommended computer-based DLS programs for autistic individuals. Since our results suggest the CFSAT is a viable computer-based program of DLS for autistic adults, CFSAT could help fill a need for DLS tools that are more applicable to real life than currently available questionnaires. Findings provide preliminary support that the CFSAT assessment measures DLS and could be a promising program to further study.

What are potential weaknesses in the study?

Weaknesses of our work include that the measures used in this study only assessed two specific tasks encountered in daily living. Data on participants' real-life experience were not fully collected, so the association between the amount of real-life experience on these tasks and computer task performance will require further study. No data asking whether the tasks studied are useful for autistic adolescents and adults were collected. The study was small and consisted of relatively fewer women, which means that results will need to be replicated in a larger sample.

How will these findings help autistic adults now or in the future?

This work could eventually pave the way for interventions that improve DLS (including the training version of the CFSAT) that may be helpful for teaching autistic individuals technology-related functional skills.

Introduction

The term adaptive functioning (AF) refers to the ability to independently navigate multiple areas of life. The AF is typically assessed for domains including communication, social functioning, and daily living skills (DLS). The DLS include abilities related to personal hygiene, meal preparation, housekeeping, transportation, and money and time management.[1] As one ages, these DLS become increasingly important for independent daily adult life. Indeed, AF ability and DLS are significant predictors of both post-secondary educational attainment and everyday outcomes in autistic adults.[2,3]

A recent study illustrated that DLS plateaued and declined after high school in an autistic sample.[2] It is, therefore, critical to develop methods of assessing and improving DLS to identify areas where greater supports are needed.

Most AF measures are parent- or self-report questionnaires that query components of AF, including DLS, across contexts. Several well-validated measures of AF and DLS include the Vineland Adaptive Behavior Scales,[4] the Adaptive Behavior Assessment System[5] (ABAS), or the Waisman Activities of Daily Living Scale.[6] However, these questionnaires rely on subjective reports and could be biased. Assessments that simulate DLS tasks in the laboratory provide a more ecologically valid way to study DLS.

Currently, the few direct assessments that measure DLS are either outdated for younger participants (e.g., rely on writing checks or dialing rotary phones)[7] or long.[8] A recent review recommended technology-based DLS programs for autistic adults.[9] Brief performance-based computer tasks that measure DLS in contemporary (and increasingly digital) situations could help identify gaps in DLS and augment information collected from questionnaires. They do not need to be administered by a clinician and can enable researchers to collect real-time data on the cognitive processes underlying DLS. A few such measures have been examined to date in autistic individuals.

To understand DLS and its mechanisms, it is important to examine other cognitive factors that may be associated with it. Studies show small or no correlations between IQ and DLS in autistic samples with above average or average IQ.[10–12] The DLS have been associated with executive functioning (EF) ability in autistic samples with average IQ.[12] In fact, a longitudinal study of autistic children and adolescents found that participants with lower EF ability at study entry also had lower DLS scores several years later. Since DLS scores did not increase as participants got older, EF might be involved in the progression of DLS ability.[13]

Given the lack of empirically validated, direct assessments for DLS in autistic individuals, the current study aimed at assessing the preliminary feasibility of implementing the Computerized Functional Skills Assessment and Training program (CFSAT). Previously validated in older populations with cognitive and functional challenges (schizophrenia and mild cognitive impairment; MCI),[14–18] CFSAT is a computerized program that first assesses and then teaches adults to complete technology-based DLS, such as using an ATM or purchasing transit tickets. Users read prompts and complete tasks on the virtual interface, with increasingly greater task demands (Supplementary Fig. S1).

The tasks are first administered as an assessment to determine baseline ability, then form the core of the training tasks. The CFSAT simulations replicate everyday functionally relevant tasks employing digital technology in a lab setting (or now in remotely deliverable versions). Standard measures of accuracy and response time provide objective measures of DLS ability. Although CFSAT cannot measure AF as comprehensively as a questionnaire that queries all domains of AF, it is easily and cost-effectively administered by a computer and realistically simulates elements of DLS. These strengths make CFSAT a promising tool to identify people who would benefit from a DLS intervention.

Given that CFSAT has never been used in an autistic population, the possibility of use with autistic participants must first be established. To that end, we administered the assessment portion of two CFSAT modules, which use the same tasks as the training portion. We hypothesized that autistic people in our study, who did not have an intellectual disability, would be able to fully complete the assessment, even at younger ages than previously studied. We also predicted that CFSAT would be sensitive to differences in performance, with autistic individuals making more errors and taking longer compared with non-autistic participants.[1]

These results would rule out ceiling or floor effects that would not recommend CFSAT for use in this population. In addition, we expected that the autistic group's performance on CFSAT tasks would correlate with a questionnaire measure of self-reported general AF and DLS. This would suggest that both assess similar constructs, providing assurance that CFSAT is a meaningful program for measuring DLS (and potentially later DLS training). For an exploratory analysis, we hypothesized that, as previously reported in autistic participants, IQ would not strongly predict performance in our sample, but EF would be a better predictor.

Methods

As part of a cohort-sequential 5-year study on development, participants completed two modules of the CFSAT during the second wave of data collection. Inclusion criteria established during the first wave of the study included having a community diagnosis on the autism spectrum confirmed by a DSM-5 Criteria Checklist[19] and the Autism Diagnostic Observation Schedule.[20] Non-autistic participants scored 11 or lower on the Lifetime version of the Social Communication Questionnaire (SCQ),[21] which queries parent recollection of social behavior and skills when their children were 4–5 years old.

All participants were required to have a full-scale IQ (FSIQ) greater than or equal to 70 (although verbal or nonverbal IQ could be lower), measured by the Wechsler Abbreviated Scale of Intelligence, Second Edition.[22] Females were recruited at a 1:4 ratio to reflect the autism gender distribution in the literature at the time.[23] For complete study details, see Solomon et al.[24] Protocol approval was obtained by the University of California, Davis Institutional Review Board and written informed consent was obtained from all participants.

Participants

Twenty-five autistic participants (age: mean 20.0 years, standard deviation [SD] = 2.8) and 25 non-autistic participants (age: mean = 19.5 years, SD = 3.2) completed the CFSAT assessment. The groups differed significantly on FSIQ (autistic: mean = 102.6, SD = 15.2; non-autistic: mean = 110.7, SD = 9.9) (Table 1). If current questionnaire data were not available, data from 2 years prior at study enrollment were used (seven non-autistic, seven autistic participants for SCQ; two non-autistic, one autistic participant for Adaptive Behavior Assessment System, Third Edition [ABAS-3]). Five autistic and seven non-autistic participants were missing ABAS-3 scores. The Lifetime version of the SCQ was used, and ABAS-3 scores are age-adjusted, so previous scores were valid.

Materials

Computerized Functional Skills Assessment and Training program. As described in Czaja et al,[25] the CFSAT includes computer-based simulations of everyday living tasks. Each of the two administered modules consisted of six subtasks with progressively more challenging demands. For the ATM module, participants were required to perform tasks such as checking balances and transferring money. For the Kiosk module, participants were required to purchase metro tickets, and add money to existing transit cards.

Real-time completion time data were collected directly by the program as were total errors. Error feedback was delivered by repetition of the original instructions in a pop-up, with four consecutive errors on the same item leading to a ''forced progression'' to the next item. The CFSAT was delivered in person. Four modules were excluded, as these tasks were targeted for older adults. These modules included medication management and telephone and Internet prescription refill, which was not relevant to our sample with a few participants on medication (a medication-free sample was initially recruited for imaging purposes).

Internet banking was not administered because of the length of the assessment and time limitations in the current study. It also bears mention that the two selected modules had factor loadings in both control and clinical adult populations

Table 1. Participant Demographic and Clinical Characteristics

	Autistic			*Non-autistic*			
Variable	n	%		n	%		p[a]
Gender							
Male	21	84		19	76		
Female	4	16		6	24		0.48
	Mean	*SD*	*Range*	*Mean*	*SD*	*Range*	
Age (years)	20.0	2.8	15–24	19.5	3.2	14–24	0.51
IQ scores							
Full scale	102.6	15.2	74–129	110.7	9.9	94–129	0.08
Verbal	99.7	16.3	58–135	107.5	11.0	85–137	0.07
Nonverbal	104.9	17.7	63–132	111.1	12.2	83–140	0.18
ABAS GAC[b]	85.4	15.7	58–118	112.1	11.4	86–120	<0.001
ABAS practical skills[b]	84.0	15.2	57–110	111.3	12.0	81–120	<0.001
ABAS community use[b]	6.5	3.8	1–13	11.6	1.9	7–13	<0.001
SCQ[c]	22.8	5.9	12–33	2.4	2.7	0–9	<0.001
ADOS-2 CSS	7.9	1.9	4–10	n/a	n/a	n/a	n/a

[a]Group differences were assessed using a chi-squared test for gender, two-sample *t*-tests for age, and Wilcoxon rank-sum tests for IQ, ABAS, and SCQ scores. All tests were two-tailed.
[b]Data missing for: five autistic and seven non-autistic participants.
[c]One autistic participant.
ABAS, Adaptive Behavior Assessment System; ABAS GAC, General Adaptive Composite Score of Adaptive Behavior Assessment System (Self-Report); ADOS-2 CSS, Autism Diagnostic Observation Schedule 2, Calibrated Severity Score; SCQ, Social Communication Questionnaire; SD, standard deviation; n/a, not applicable.

on the single overall performance latent trait (confirmed with maximum likelihood tests of goodness of fit) that were similar to each other (0.92 and 0.93, respectively) and similar to the average factor loadings for the other 4 modules (mean loading = 0.89).[17]

Adaptive Behavior Assessment System, Third Edition. The ABAS-3 is a self-report questionnaire that comprehensively assesses AF.[5] It provides a General Adaptive Composite (GAC) score, and composite scores on Conceptual, Social, and Practical skills. The Practical skills domain—a measure of DLS—contains skills needed to take care of oneself in home, work, and classroom settings, address personal and health needs, and function within a community.

This domain also has a Community Use subscale that directly queries ATM use. Higher scores reflect stronger AF. The ABAS-3 is better suited for individuals with higher intellectual ability than the Vineland Adaptive Behavior Scales[4] since it covers more advanced abilities and has a self-report form for those aged 16 and older.

NIH Toolbox Cognition Battery. The NIH Toolbox Cognition Battery[26] was used to measure EF and completed at the same time as the CFSAT. It consists of seven tasks completed on an iPad and produces scores of Total Cognition (fluid and crystalized). Unadjusted scores were used to better examine the independent effects of age.

Analysis

For each participant, CFSAT errors and time to completion were averaged across the two modules to create overall measures of performance. Group differences in average errors and completion time were assessed using Wilcoxon rank-sum tests, given non-normal data distributions. Convergent validity was examined by calculating Spearman's rank correlations between average errors and completion time and self-reported scores of AF and DLS within groups. Within each group, we used false discovery rate with alpha = 0.05 to correct *p*-values for multiple comparisons.

We used linear regression analysis to examine the effect of NIH Toolbox Total Cognition scores (representing EF), FSIQ, and age on task performance in the autistic and non-autistic participants. Thus, for both average errors and average completion time, we fitted two separate models to examine the two predictors of interest, NIH Toolbox Total Cognition scores, and FSIQ, independently. The outcomes were log transformed to improve distributional assumptions.

The terms included in each model were group (Autistic, Non-autistic), age (centered at the mean), Total Cognition score (or IQ, respectively; centered at the mean), and the interaction between Total Cognition (or IQ, respectively) and group. The interaction terms between Total Cognition/IQ scores and group test for differences in the effect of Total Cognition/IQ scores on performance between groups.

Results

All participants completed both modules except for one autistic individual who opted to end the Ticket Kiosk module before completion. This individual asked for help reading and clarifying the prompts to the extent that administration was biased. Another autistic participant's error score on the ATM module was missing due to an administration error. A Wilcoxon rank-sum test revealed that the autistic (median = 5.5) group made significantly more errors than the non-autistic (median = 3.5) group ($z = 3.04$, $p < 0.01$), but completion time did not differ between groups.

In the autistic group, Spearman's correlations corrected for multiple comparisons showed that making fewer errors on the CFSAT were strongly associated with higher General Adaptive Composite Score of Adaptive Behavior Assessment System

(Self-Report) (ABAS GAC) scores, $\rho(19) = -0.56$, $p = 0.03$ and higher ABAS Practical skills scores, $\rho(19) = -0.54$, $p = 0.03$. Shorter completion times, but not error rates, were strongly associated with higher ABAS Community Use scores, $\rho(20) = -0.65$, $p = 0.01$.

No correlations were significant in the non-autistic group. In a *post hoc* analysis, we examined history of ATM use, which, as mentioned earlier, is assessed directly in the ABAS-3, in both groups. Most non-autistic participants had experience with ATMs (17/18, 94%) versus only a little more than half of the autistic participants (11/20, 55%).

In the regression analysis using the NIH Toolbox Total Cognition score to predict task performance, older age was associated with fewer errors and shorter completion times (Table 2, Model 1). The interaction between group and Total Cognition scores was significant, such that higher cognition scores predicted better task performance in autistic but not non-autistic participants. In autistic participants, for every 1-point increase in cognition score, the number of errors decreased by about 5.4%, and the completion time by about 1.9%.

The pattern for the regression using FSIQ was similar, but the interaction between group and IQ score did not reach statistical significance in the model predicting errors ($p = 0.08$).

In a sensitivity analysis restricted to the participants who had both ABAS-3 and complete CFSAT data, we added real-life self-reported ATM experience (a question on the ABAS-3), coded yes/no, to the models. The magnitude of the association between cognition scores and task performance was similar to the original analysis, with the number of errors decreasing by about 6.5%, and the completion time by about 1.8% for every 1-point increase in cognition score in autistic participants.

Discussion

This pilot study investigated a performance-based measure of DLS by comparing task performance between autistic and non-autistic participants and relating performance to existing measures of DLS (ABAS-3) and EF (NIH Toolbox Cognition Scores). Virtually all autistic participants were able to complete the two CFSAT modules studied. The autistic group made more errors but did not differ from the non-autistic group on completion times. This made more errors correlated with lower self-reported general AF and DLS in the autistic group.

Autistic participants who took longer to complete the tasks also self-reported lower ABAS-3 Community Use scores. Although IQ and EF measures correlated in the whole group [$r(48) = 0.71$, $p < 0.001$], the EF measure predicted CFSAT performance better than IQ in the autistic group. Neither measure predicted performance in the non-autistic group. Although comprehensive data concerning participants' experience with the CFSAT tasks were not collected, self-reported experience using an ATM was added to the models. This only slightly influenced the magnitude of the relationship between EF and CFSAT performance in autistic participants.

These data provide preliminary support for using CFSAT as an assessment of DLS in an adolescent and young adult autistic population. The program was difficult enough to detect a broad range of DLS levels without ceiling or floor effect in the autistic group. The autistic group made more errors, with more than a quarter of the autistic sample making as many or more errors than the bottom 5% of the non-autistic group. Thus, the assessment portion of CFSAT could be used to identify participants who would most benefit from the DLS intervention.

The CFSAT errors correlated highly with self-reported AF and DLS in the autistic group, suggesting construct overlap between CFSAT and an existing measure of AF. It is notable that although the tasks tested here were highly specific, CFSAT errors still also corresponded to a generalized measure of AF, the ABAS GAC. Faster completion times

Table 2. Summary of the Linear Regression Models Predicting Average Errors and Completion Times

	Errors[a]		*Completion time*[a]	
Model term	*Estimate (SE)*	p	*Estimate (SE)*	p
Model 1				
Intercept	1.139 (0.140)	<0.001	1.898 (0.048)	<0.001
Age (years)	–0.085 (0.027)	0.003	–0.024 (0.009)	0.01
Autism diagnosis	0.567 (0.182)	0.003	0.056 (0.063)	0.38
Total cognition	–0.004 (0.018)	0.82	–0.002 (0.006)	0.75
Autism diagnosis × total cognition	–0.051 (0.020)	0.02	–0.017 (0.007)	0.02
R^2	60.9%		54.7%	
Model 2				
Intercept	1.115 (0.135)	<0.001	1.900 (0.039)	<0.001
Age (years)	–0.100 (0.031)	0.002	–0.030 (0.009)	0.002
Autism diagnosis	0.690 (0.190)	<0.001	0.076 (0.055)	0.17
FSIQ	–0.001 (0.013)	0.94	–0.004 (0.004)	0.29
Autism diagnosis × FSIQ	–0.028 (0.016)	0.08	–0.012 (0.005)	0.01
R^2	46.4%		56.0%	

We averaged the number of errors and completion times for the two modules. Participants who had data for only one of the modules were not included in this analysis (two autistic participants for errors models and one autistic participant for completion time models).

[a]From linear regression models using log transformed number of errors and completion time as dependent variables and the terms listed in the first column as independent variables. All continuous variables (age, Total Cognition, FSIQ) were centered at their mean before being included in the models. R^2 represents the percent of the total variability in the outcomes explained by each model. The results were similar when real-life self-reported ATM experience (a question on the ABAS-3), coded yes/no, was added to both models.

ABAS-3, Adaptive Behavior Assessment System, Third Edition; FSIQ, full-scale IQ; SE, standard error.

correlated with the ABAS subscale that measures ATM use in real life (no data on real-life ticket machine use was available). This suggests that familiarity with an ATM could increase speed. For those without experience using an ATM, a program such as the intervention part of CFSAT could increase familiarity in a controlled, safe setting.

Given that EF ability has been shown to predict DLS,[13] results of regression analyses using NIH Toolbox Total Cognition scores as a measure of EF were not surprising. Toolbox scores were a significant predictor of CFSAT performance in autistic but not non-autistic participants. Given this association, it is possible that interventions that improve EF could also promote DLS, or, as previously reported,[27] training on DLS with the CFSAT could exert a beneficial effect on EF.

This study is limited by a small sample size, which constrains the analyses conducted and the breadth of conclusions that can be drawn. The CFSAT may not be appropriate for autistic people with an intellectual disability. The study was also initiated before recent work, suggesting a more even gender distribution[28,29] and thus our autistic participants may not be fully representative.

Finally, with more extensive data about prior technology use in our sample, the researchers could have examined how familiarity with the task affected performance, which is an interesting future direction. In the current study, only 55% of autistic participants reported prior experience using an ATM. A further documented lack of experience with these technology-based DLS tasks would speak to the need for a program such as CFSAT.

In conclusion, CFSAT appears to provide a way to measure DLS in autistic adults without intellectual disability. Although this study only looked at two DLS, using an ATM and a Metro Ticket Machine, new CFSAT modules that simulate other important DLS (e.g., mobile phone usage, online shopping, and arranging home deliveries) have been developed in later editions of the CFSAT. Thus, in the future, it may be possible to implement a wider array of modules with autistic people. The intervention portion of CFSAT could be used to scaffold the development of important life skills, including those that are reliant on practice.

Acknowledgments

Thanks are due to Raphael Geddert and Nada Dalloul for help with data collection.

Authorship Confirmation Statement

M.S. and P.D.H. contributed to the study conception and design. Data analysis was performed by A.-M.I. and R.A.W., who along with M.K.K. and M.S. helped with data interpretation. The first draft of the article was written by R.A.W., and all authors commented on previous versions of the article. All authors read and approved the final article.

Author Disclosure Statement

Dr. Harvey has received consulting fees or travel reimbursements from Alkermes, Bio Excel, Boehringer Ingelheim, Karuna Pharma, Minerva Pharma, and Sunovion Pharma during the past year. He receives royalties from the Brief Assessment of Cognition in Schizophrenia (Owned by Verasci, Inc.). He is chief scientific officer of iFunction, Inc., the owner of the CFSAT software. The remaining authors have no conflicts of interest relevant to the content of this article to declare.

Funding Information

Funding was provided by a generous donation from David Follette, MD, a grant from the National Institute of Health: R01MH106518 (principal investigator: M.S.), and the MIND IDDRC grant (P50HD103526).

Supplementary Material

Supplementary Figure S1

References

1. Bal VH, Kim SH, Cheong D, et al. Daily living skills in individuals with autism spectrum disorder from 2 to 21 years of age. Autism 2015;19(7):774–784; doi: 10.1177/1362361315575840
2. Clarke EB, McCauley JB, Lord C. Post-high school daily living skills outcomes in autism spectrum disorder. J Am Acad Child Adolesc Psychiatry 2021;60(8):978–985; doi: 10.1016/j.jaac.2020.11.008
3. Farley MA, McMahon WM, Fombonne E, et al. Twenty-year outcome for individuals with autism and average or near-average cognitive abilities. Autism Res 2009;2(2):109–118; doi: 10.1002/aur.69
4. Sparrow SS, Cicchetti DV. Diagnostic uses of the Vineland Adaptive Behavior Scales. J Pediatr Psychol 1985;10(2):215–225; doi: 10.1093/jpepsy/10.2.215
5. Harrison PL, Oakland T. ABAS-3: Adaptive Behavior Assessment System. Western Psychological Services: Los Angeles, CA; 2015.
6. Maenner MJ, Smith LE, Hong J, et al. Evaluation of an activities of daily living scale for adolescents and adults with developmental disabilities. Disabil Health J 2013;6(1):8–17; doi: 10.1016/j.dhjo.2012.08.005
7. Patterson TL, Goldman S, McKibbin CL, et al. UCSD performance-based skills assessment: Development of a new measure of everyday functioning for severely mentally ill adults. Schizophr Bull 2001;27(2):235–245; doi: 10.1093/oxfordjournals.schbul.a006870
8. Ruse SA, Harvey PD, Davis VG, et al. Virtual reality functional capacity assessment in schizophrenia: Preliminary data regarding feasibility and correlations with cognitive and functional capacity performance. Schizophr Res Cogn 2014;1(1):e21–e26; doi: 10.1016/j.scog.2014.01.004
9. Hrabal JM, Davis TN, Wicker MR. The use of technology to teach daily living skills for adults with autism: A systematic review. Adv Neurodev Disord 2022; doi: 10.1007/s41252-022-00255-9
10. Kenworthy L, Case L, Harms MB, et al. Adaptive behavior ratings correlate with symptomatology and IQ among individuals with high-functioning autism spectrum disorders. J Autism Dev Disord 2010;40(4):416–423; doi: 10.1007/s10803-009-0911-4
11. Duncan AW, Bishop SL. Understanding the gap between cognitive abilities and daily living skills in adolescents with autism spectrum disorders with average intelligence. Autism 2015;19(1):64–72; doi: 10.1177/1362361313510068

12. Pugliese CE, Anthony L, Strang JF, et al. Increasing adaptive behavior skill deficits from childhood to adolescence in autism spectrum disorder: Role of executive function. J Autism Dev Disord 2015;45(6):1579–1587; doi: 10.1007/s10803-014-2309-1
13. Pugliese CE, Anthony L, Strang JF, et al. Longitudinal examination of adaptive behavior in autism spectrum disorders: Influence of executive function. J Autism Dev Disord 2016;46(2):467–477; doi: 10.1007/s10803-015-2584-5
14. Czaja SJ, Loewenstein DA, Sabbag SA, et al. A novel method for direct assessment of everyday competence among older adults. J Alzheimers Dis 2017;57(4):1229–1238; doi: 10.3233/JAD-161183
15. Czaja SJ, Loewenstein DA, Lee CC, et al. Assessing functional performance using computer-based simulations of everyday activities. Schizophr Res 2017;183:130–136; doi: 10.1016/j.schres.2016.11.014
16. Harvey PD, Tibiriçá L, Kallestrup P, et al. A Computerized Functional Skills Assessment and Training program targeting technology based everyday functional skills. J Vis Exp 2020;(156); doi: 10.3791/60330
17. Harvey PD, Forero DB, Ahern LB, et al. The Computerized Functional Skills Assessment and Training program: Sensitivity to global cognitive impairment, correlations with cognitive abilities, and factor structure. Am J Geriatr Psychiatry 2021;29(4):395–404; doi: 10.1016/j.jagp.2020.08.019
18. Nucifora FC, Baker KK, Stricklin A, et al. Better functional capacity and cognitive performance in clozapine responders compared to non-responders: A cross-sectional study. Schizophr Res 2021;229:134–136; doi: 10.1016/j.schres.2020.11.018
19. American Psychiatric Association. The Diagnostic and Statistical Manual of Mental Disorders: DSM-5. 5th ed. American Psychiatric Association; 2013.
20. Lord C, Rutter M, DiLavore PC, et al. Autism Diagnostic Observation Schedule, Second Edition (ADOS-2). Western Psychological Services: Los Angeles, CA; 2012.
21. Rutter M, Bailey A, Lord C. SCQ: Social Communication Questionnaire. Western Psychological Services: Los Angeles, CA; 2003.
22. Wechsler D. Wechsler Abbreviated Scale of Intelligence (WASI-II). 2nd ed. NCS Pearson, Inc.: Bloomington, MN; 2011.
23. Maenner MJ, Shaw KA, Baio J, et al. Prevalence of autism spectrum disorder among children aged 8 years—Autism and developmental disabilities monitoring network, 11 sites, United States, 2016. MMWR Surveill Summ 2020; 69(4):1–12; doi: 10.15585/mmwr.ss6904a1
24. Solomon M, Gordon A, Iosif AM, et al. Using the NIH toolbox to assess cognition in adolescents and young adults with autism spectrum disorders. Autism Res 2021;14(3): 500–511; doi: 10.1002/aur.2399
25. Czaja SJ, Kallestrup P, Harvey PD. Evaluation of a novel technology-based program designed to assess and train everyday skills in older adults. Innov Aging 2020;4(6): igaa052; doi: 10.1093/geroni/igaa052
26. Akshoomoff N, Beaumont JL, Bauer PJ, et al. NIH toolbox cognition battery: composite scores of crystallized, fluid, and overall cognition. Monogr Soc Res Child Dev 2013; 78(4):119–132; doi: 10.1111/mono.12038
27. Harvey PD, Zayas-Bazan M, Tibiriçá L, et al. Improvements in cognitive performance with computerized training in older people with and without cognitive impairment: Synergistic effects of skills-focused and cognitive-focused strategies. Am J Geriatr Psychiatry 2022;30(6):717–726; doi: 10.1016/j.jagp.2021.11.008
28. Posserud MB, Skretting Solberg B, Engeland A, et al. Male to female ratios in autism spectrum disorders by age, intellectual disability and attention-deficit/hyperactivity disorder. Acta Psychiatr Scand 2021;144(6):635–646; doi: 10.1111/acps.13368
29. Loomes R, Hull L, Mandy WPL. What is the male-to-female ratio in autism spectrum disorder? A systematic review and meta-analysis. J Am Acad Child Adolesc Psychiatry 2017; 56(6):466–474; doi: 10.1016/j.jaac.2017.03.013

Address correspondence to:
Marjorie Solomon
Department of Psychiatry and Behavioral Sciences
MIND Institute
2825 50th Street
Sacramento, CA 95817
USA

Email: marsolomon@ucdavis.edu