Journal of Intellectual Disability Research doi: 10.1111/j.1365-2788.2006.00854.x

VOLUME 51 PART 2 pp 142–150 FEBRUARY 2007

Supported employment improves cognitive performance in adults with Autism

D. García-Villamisar[1] & C. Hughes[2]

1 *Universidad Complutense de Madrid and Nuevo Horizonte Association,Madrid, Spain*
2 *Centre for Family Research, University of Cambridge, Free School Lane, Cambridge, UK*

Abstract

Background The purpose of this study was to examine the effects of a supported employment programme on measures of executive functions for 44 adults with autism, assessed at the beginning and the end of the programme period. The average length of time of the community employment was 30 months.
Methods Based on their predominant work activity over the study period, participants were classified into two groups: supported employment and unemployed. At the start of the programme, the groups did not differ on any of the cognitive measures.
Results Repeated measures analysis of variance (ANOVA) demonstrated that by the end of the programme, the supported employment group showed higher scores for executive functions on variables of CANTAB (Spatial Span Task – span length recalled; Spatial Working Memory Task – strategy; Planning task 'Stockings of Cambridge' – problems solved in minimum moves; Planning task 'Stockings of Cambridge' – mean planning time) and other tasks such as Trail Making Test – part B, time; Matching Familiar Figures (first answer and errors). In contrast, the unemployed group showed no change over time in their cognitive performance.
Conclusion Results of this study suggested that vocational rehabilitation programmes have a beneficial impact upon cognitive performance in people with autism.

Keywords autism, CANTAB, cognitive variables, supported employment

Introduction

Autism[1] is a life-long developmental disorder that profoundly affects multiple aspects of an individual's functioning, and includes a triad of impairments in reciprocal social interactions, interpersonal communication and imagination Wing 2002). This third area of abnormality also includes non-social impairments Happé 1999), characterized as 'restricted repetitive and stereotyped patterns of behaviour, interests, and activities' in DSM-IV American Psychiatric Association 1994).

Correspondence: Domingo García-Villamisar, Departamento de Personalidad, Evaluación y Psicología Clínica I, Facultad de Educación, Avda, Juan XXIII, s/n, Universidad Complutense, 28040, Madrid, Spain (e-mail: villamisar@correo.cop.es).

[1]For reasons of parsimony, the term 'autism' will be used throughout to describe individuals with autism and the related 'pervasive developmental disorders' described in DSM-IV-TR (American Psychiatric Association 1994) and ICD-10-CM (Whold Health Organization 2003), and commonly referred to as 'autism spectrum disorders'.

Over the past 10 years, there has been a growing interest in the rehabilitation of adults with autism Bennetto 2002; García-Villamisar 2002). Although most adults with autism have remained in institutions, the last three decades have seen the founding and development of non-institutional programmes for adults. These efforts are limited by a lack of both appropriate financial support and empirical validation. Supported employment is a supportive approach to hiring and retaining people with developmental disabilities (supported employees). A specialized trainer, known as a job coach or employment specialist, provides individualized training for the supported employee. Supported employment is highly adaptive to individual and organizational needs.

The mission of the supported employment programme is to provide a stable and predictable work environment whereby the person with autism can, as independently as possible, be a contributing member of the workforce. These contributions allow the people with autism to increase their sense of self-worth, and, at the same time, help to increase public awareness and understanding of autism.

Within each supported employment programme, there is an emphasis on using individual strengths and interests, identifying appropriate jobs and settings, applying structured teaching techniques, collaborating with families, caregivers and employers, providing necessary long-term support services, and ensuring the appropriate 'fit' so that the employee, employer and family/caregiver are all satisfied.

Supported employment enables people with disabilities who have not previously been successfully employed to work and to contribute to society. Supported employment focuses on a person's abilities and provides the supports that the individual needs to be successful on a long-term basis. The supported employment has three characteristics: paid employment, an integrated work setting and ongoing support Wehman 2000). People with severe or profound autism have often been placed in prevocational centres, sheltered workshops or day activity centres. People with mild or moderate autism are those who benefit the most from the supported employment García-Villamisar 2000). Although not all people with autism have the same level of vocational skills, many are able to participate in supported employment programmes.

Abnormal cognitive performance has been observed in people with autism in an impressive number of studies (for a review, see Ozonoff 1997), which demonstrate that autism is associated with a wide range of cognitive deficits (attention, memory and executive functions). More recently, researchers have advanced this line of investigation to focus on the relationships between cognitive functioning and the rehabilitation status within spectrum autistic disorders Bennetto 2002). There is replicated evidence that cognition is related to the current level of functioning Bennetto 2002). In broad terms, cognitive strengths can facilitate adaptive functioning, but cognitive deficits can be important obstacles for integration into social and work environment. A key issue then is whether supported employment can facilitate the compensation of cognitive deficits. More specifically, what types of employment might have such benefits? And does supported employment also improve non-vocational outcomes? Recent studies have examined the experiences and effects of working, with a focus on the non-vocational (cognitive) outcomes, for individuals with psychiatric problems (not including people with autism) Drake *et al.* 2003). For example, Bell *et al.* (2001) demonstrated that patients with schizophrenia or schizoaffective disorder showed improved neuropsychological functioning following neurocognitive enhancement therapy in combination with work therapy. In this study, we hypothesized that supported employment would have a positive effect on cognitive and executive functioning.

To address this proposal, we examined baseline cognitive performances from a group of people with autism, classified by occupational status: competitive employment vs. employment or vocational activities in non-working settings during a follow-up period of 3 years.

Method

Participants

Participants in this study included 44 adults (32 men and 12 women) with autism all diagnosed according to DSM-IV criteria APA 1994) and with Childhood Autism Rating Scale (CARS; Schopler *et al.* 1988) total score > 30. These participants were drawn from a large sample taking part in the Spanish Program of

Employment for Autistic People. The selection of the sample of participants was random. Their educational level is elementary, and the average number of years of schooling was 5.31 (range: 3–7; SD: 1.35). All participants were required to score above the 35th percentile point on the Standard Progressive Matrices (SPM). The SPM is a non-verbal test chosen to avoid the problems embedded in the use of verbal measurements in assessing 'intelligence' in autistic adults Hobson 1991). Prior to recruitment, all participants were screened to check for any history of psychiatric disorder, neurological disorder or head injury. All participants were also required to be medication free at the time of testing. Informed consent was obtained from each individual or carer where appropriate. All factors remained stable during employment/control periods, respectively: medication, activities and tasks and behaviour problems. The demographic and clinical characteristics of the sample are shown in Table 1.

All jobs were located in the community, and no more than two individuals with autism were placed at the same workplace. The community jobs were predominantly in the service sector and included: food services, waiters, recycling and delivery, retail, gardening, industrial laundry, agriculture and cattle raising, etc. All participants worked on average 20 h per week and were paid with competitive wages based on rates for non-handicapped workers in training. A job coach was assigned to each worker with autism. The supported employment participants were selected according to the following criteria: sheltered workshops enrolment prior to the participation in the supported work programme (minimum 2 years); no previous participation in other supported employment programmes; diagnosis of autism; no severe behavioural problems, acceptable professional and vocational abilities, and informed consent. The average length of time of the community employment was 30 months. A second group on the waiting list participated in non-competitive vocational activities during the development of the project. At each time-point, the entire evaluation, including the Cambridge Neuropsychological Tests: Automated Battery (CANTAB), took approximately 2 h to complete.

Computerized task measures

Participants' memory and executive functions were evaluated at the beginning and at the end of the programme, using a series of neuropsychological tests from CANTAB. These tests were presented on a high-resolution touch-screen monitor under computer control. The CANTAB series has been described in detail by Robins *et al.* (1994, unpublished results, 1997), Hughes & Graham (2002) and Brophy *et al.* (2002). Several groups of researchers have employed CANTAB to document executive function impairments in individuals with autism (e.g. Hughes *et al.* 1994; Turner 1997; Ozonoff *et al.* 2004) and their relatives (e.g. Hughes *et al.* 1997, 1999). The CANTAB used in the present study included two control tasks: Big Circle/Little Circle (BLC), which assesses psychomotor speed, and Spatial Recognition Memory (SRM) and Span Tasks (SST), as

Table 1 Demographic and clinical characteristics of the participants

	Supported work		No supported work		
	Mean	SD	Mean	SD	Student's *t*
Age (years)	25.52	3.35	24.32	4.34	$t_{(20)} = 0.95$; $P = 0.35$; NS
Education (years)	5.04	1.5	4.52	1.29	$t_{(20)} = 1.89$; $P = 0.29$; NS
BPVS (raw scores)	80.81	8.51	82.42	6.92	$t_{(20)} = -0.61$; $P = 0.55$; NS
Raven's matrices (raw scores)*	41.14	4.45	42.23	5.43	$t_{(20)} = 1.42$; $P = 0.32$; NS
CARS	34.81	5.19	33.19	6.65	$t_{(20)} = 1.07$; $P = 0.33$; NS

*All those participating were required to score above the 35th percentile on the Standard Progressive Matrices.
BPVS, British Picture Vocabulary Scale, Spanish version; CARS, Childhood Autism Rating Scale; NS, not significant.

well as a set of executive tasks: Intradimensional/Extradimensional (ID/ED) attentional set-shifting task; Spatial Working Memory Task; and Tower of London Planning Task.

Big Circle/Little Circle (BLC)

This control task taps the ability to follow a rule and reverse this rule. Participants were first instructed to touch the smaller of two circles on the screen, and then after 20 trials to touch the larger circle. Performance is indexed by the percentage of correct responses.

Spatial Recognition Memory (SRM) Task

This task assesses the ability to remember the spatial location of visual stimuli. Five squares are shown in a sequence at different points on the screen. Participants were then shown a pair of squares and asked to identify the location at which these squares were previously presented. Performance is indexed by the number of correct responses.

Span Task (SST)

This test is similar to the Corsi Block Test Milner 1971) and examines the ability of the participants to remember the location of sequentially presented stimuli. A pattern of white squares is shown on the screen. A (variable) sequence of squares briefly change colour, one by one. Participants were asked to touch the squares in the same order in blocks of increasing length, from two to nine squares. Performance is determined by the longest sequence successfully recalled.

Spatial Working Memory Task (SWM)

In this task, participants were required to 'search through' a number of boxes presented on the screen by touching each one so that it opens up, revealing what was inside. The object of the task is to collect blue tokens hidden inside the boxes and once found, to use them to fill an empty column at the side of the screen. The participants were instructed that once a token is discovered in a box, that box will no longer hide tokens until the tokens in that search trial have been found. By gradually increasing the number of tokens to be found, the difficulty of this task can be increased. Previous research Owen *et al.* 1998) has shown that 'between errors' (i.e. returning to open a box in which a blue token has already been found) are sensitive to frontal lobe dysfunction. Consequently, our analyses focus on between search errors. Efficiency in search strategies can also be evaluated in this task, and is indexed by the number of different starting points used for each search trial. A low number indicates more efficient searching, while a high score shows a poor strategy.

Intradimensional/Extradimensional (ID/ED) attentional set-shifting task

This test was designed to examine in greater detail the process that is evaluated by Wisconsin Card Sorting Test (WCST) Berg 1948). It assesses the ability to transfer learning within a stimulus dimension (ID) and to learn a new rule that requires shifts attention to a previously irrelevant stimulus dimension (ED). In other words, this task measures the ability to attend to attributes of compound stimuli, shifting attention from one attribute to another when required. The number of errors before and during the ED set shift and the number of stages or categories completed are recorded.

'Stockings of Cambridge' (SOC) Planning task

This task is a computerized version of the Tower of London Planning Task. Two sets of three coloured balls are presented, one set in a 'goal' arrangement on the top half of the screen and the other in a 'start' arrangement on the bottom half. Participants are asked to rearrange the coloured balls in the lower half to match the goal arrangement in the minimum number of moves. The time to plan the sequence of five the total number of problems solved in minimum moves is recorded.

Paper-and-pen cognitive measures

Trail Making Test (TMT)

The TMT Reitan & Wolfson 1993) is given in two parts (A and B). Part A (TMT-A) involves drawing a line connecting consecutive numbers from 1 to 15. Part B (TMT-B) involves drawing a similar line connecting alternating numbers (1–8) and letters (A–G) in a sequence (i.e. 1-A-2-B and so on). Performance is rated by the time taken to complete each 'trial'

(test) – the key measure on this task is the time required to complete part B.

Matching Familiar Figures Test (MFFT)

The MFFT Kagan *et al*. 1964; Kagan 1966) has 12 sets of test items. Each set includes a target figure and an array of six figures, only one of which matches the target. Participants are required to point out the identical variant among the six alternatives. Performance is rated by the reaction time of the first response (correct or not) for all 12 trials and the total number of errors.

The Word Fluency Test (WFT)

In the WFT (e.g. Miller 1984; García-Villamisar & Della Sala 2002), the participants were asked to orally use as many words as they could, beginning with a given letter in 60 s. The letters F, A and S were used. The score was the average number of words produced, averaged across the three letters.

Statistical analyses

Statistical analyses consisted of a *t*-test and a series of univariate analyses, comparing supported employment and non-supported employment groups on all demographic, clinical and neuropsychological measures. Between-group and intra-group differences on neuropsychological variables were examined with repeated measures analysis of variance (ANOVA). All analyses were conducted using the SPSS statistical package (12.0 version).

Results

Baseline cognitive performance

We compared the baseline cognitive performance of participants who did and those who did not achieve employment at the beginning of the employment programme. Table 2 illustrates the measurements of different tasks. The performance/results of the two groups was practically identical, with no statistically significant difference (see Table 2).

Cognitive performance at the end of the programme

Table 3 shows the results of the cognitive performance at the end of the programme (average 30 months) as compared with at the start of the programme.

The repeated measures ANOVA showed that at the end of the programme, people with autism enrolled in the supported employment programme achieved significantly higher performances than the non-

Table 2 Baseline cognitive performance supported employment vs. non-supported employment

Construct	Task measure	Supported Mean (SD)	Non-supported Mean (SD)	*F*
Big Circle/Little Circle (BLC)	Number of correct responses	39.38 (0.97)	39.52 (0.73)	0.30
Spatial Span Task (SST)	Span length recalled	3.90 (0.14)	3.78 (1.17)	0.12
Spatial Working Memory Task (SWM)	Between errors	68.14 (14.55)	67.91 (13.2)	0.01
Spatial Working Memory Task (SWM)	Strategy	38.19 (2.11)	39.26 (2.84)	1.97
Intradimensional/Extradimensional (ID/ED)	Stages completed	7.48 (5.11)	7.39 (0.94)	0.13
Intradimensional/Extradimensional (ID/ED)	Errors	16.90 (10.94)	19.69 (10.75)	0.73
Planning task 'Stockings of Cambridge'	Problems solved in minimum moves	5.10 (2.47)	5.91 (2.45)	1.23
Planning task 'Stockings of Cambridge'	Average planning time	6.71 (3.02)	6.91 (3.38)	0.042
TMT – part B	Time	55.48 (18.27)	66.22 (23.75)	2.79
MFFT	Time of 1st answer	16.33 (4.86)	17.43 (3.91)	0.039
MFFT	Errors	7.76 (2.84)	7.96 (3.62)	0.69
Fluency	Average number of words produced	39.38 (0.97)	39.52 (0.73)	2.83

MFFT, Matching Familiar Figures Test; TMT, Trail Making Test.

Table 3 ANOVA analysis – repeated measures – of interaction of groups (SE vs. NSE) by time (start of programme vs. end of programme)

		Start of programme		End of programme		
Construct	**Task measure**	**SE M (SD)**	**NSE M (SD)**	**SE M (SD)**	**NSE M (SD)**	**ANOVA**
Big Circle/Little Circle (BLC)	Number of correct responses	39.38 (0.97)	39.52 (0.73)	39.48 (0.87)	39.25 (0.96)	$F_{1,42} = 2.07$
Spatial Span Task (SST)	Span length recalled	3.90 (1.14)	3.78 (1.47)	4.85 (0.79)	3.96 (0.93)	$F_{1,42} = 5.60$*
Spatial Working Memory Task (SWM)	Between errors	68.14 (14.55)	67.91 (13.22)	61.91 (12.38)	66.13 (13.19)	$F_{1,42} = 23.73$***
Spatial Working Memory Task (SWM)	Strategy	38.19 (2.11)	39.26 (2.85)	34.00 (2.19)	37.43 (2.92)	$F_{1,42} = 10.71$***
Intradimensional/ Extradimensional (ID/ED)	Stages completed	7.48 (0.51)	7.39 (0.94)	7.43 (0.51)	7.30 (0.47)	$F_{1,42} = 0.02$
Intradimensional/ Extradimensional (ID/ED)	Errors	16.90 (10.94)	19.69 (10.75)	12.71 (6.71)	17.13 (9.15)	$F_{1,42} = 0.91$
Planning task 'Stockings of Cambridge'	Problems solved in minimum moves	5.10 (2.47)	5.91 (2.45)	7.38 (1.80)	5.57 (1.88)	$F_{1,42} = 23.31$**
Planning task 'Stockings of Cambridge'	Average planning time	6.71 (3.02)	6.91 (3.38)	4.86 (2.54)	7.61 (3.04)	$F_{1,42} = 35.16$***
TMT – part B	Time	55.48 (18.27)	66.22 (23.75)	51.14 (15.19)	66.43 (23.03)	$F_{1,42} = 21.87$***
MFFT	Time of 1st answer	16.33 (4.86)	17.43 (3.91)	10.76 (4.30)	15.96 (4.14)	$F_{1,42} = 11.65$***
MFFT	Errors	7.76 (2.84)	7.96 (3.62)	5.05 (1.47)	8.04 (2.88)	$F_{1,42} = 34.09$***
Fluency	Average number of words produced	39.38 (0.97)	39.52 (0.73)	39.48 (0.87)	39.26 (0.96)	$F_{1,42} = 4.32$

SE, supported employment; NSE, non-supported employment; MFFT, Matching Familiar Figures Test; TMT, Trail Making Test.
* = .05; ** = .01; *** = .001.

supported employment group. The interaction between *group* (supported vs. non-supported employment) and *time* (start vs. end of programme) was significant for several Executive Functions (EF) measures. These included: spatial span ($F_{1,42} = 5.60$; $P < 0.05$); between errors ($F_{1,42} = 23.73$; $P < 0.001$) and strategy scores ($F_{1,42} = 10.71$; $P < 0.001$) on the SWM; minimum move solutions ($F_{1,42} = 23.31$; $P < 0.001$) and mean planning time ($F_{1,42} = 35.16$; $P < 0.001$) on the SOC task; time on the TMT-B ($F_{1,42} = 21.87$; $P < 0.001$); and time ($F_{1,42} = 11.65$; $P < 0.001$) and errors ($F_{1,42} = 34.09$; $P < 0.001$) on the MFFT (see Table 3).

These results show that the follow-up supported employment programme was associated with an improvement, with a medium effect size being found for half the test variables of supported employment. Therefore, the supported employment programmes have a positive effect in the cognitive rehabilitation of people with autism. Only four measures did not show differences at the end of the programme. These measures were performance on a control task (BLC); two measures from the ID/ED shifting task (stage reached, and errors) and Fluency.

Discussion

Our findings highlight the positive contribution of vocational rehabilitation to cognitive functioning in people with autism. In this study, adults with autism who worked in supported employment showed significantly greater improvement in several non-vocational outcomes (distinct measures of cognitive performance). At the start of the vocational programme, there was no group difference for any of the cognitive measures, while at the end of the programme, the group enrolled in supported employment showed better performance on more than half

of the tasks in the cognitive battery. This demonstrates that active engagement in the work setting can help people with autism to improve their cognitive skills, or, in words of Black (1988), 'work is therapy'. These results are broadly consistent with those achieved in other pathologies Bellak *et al.* 1999; Gold *et al.* 1999, 2002; Drake *et al.* 2003).

Our results of supported employment provide an ecological demonstration that executive functions have a direct relationship with the real life of individuals with autism, because work experience in a variety of occupations had a notable impact on the greater part of the executive function variables of our study. Thus the success of supported employment programmes should not be examined simply by the number of participants with autism enrolled, nor by the salaries achieved. Non-vocational outcomes (such as cognitive performance) should also be analysed.

However, the changes in cognitive performance observed in this study must be interpreted with caution because of the nature of executive functioning. First, less novel tasks place lower demands on executive functions, so improvement over time might reflect reduced novelty; however, this does not appear to be a concern in the present study as the control group showed no improvement in performance. Second, executive function is generally regarded as a multidimensional behavioural construct that covers a range of higher-order cortical functions, such as working memory, planning, shifting, updating, etc. Burgess 1997; Fuster 1997; Anderson 1998; Miyake *et al.* 2000; Lehto *et al.* 2003; Hill 2004a,b). Further work is therefore needed to establish which aspects of executive function are most sensitive to the positive effects of supported employment. Third, the interpretation of our data is also limited by the multicomponential nature of executive functions tests. As a result, future efforts to elucidate the mechanisms underpinning the positive effects of supported employment should include fine-grain measures of specific components of executive function.

The key finding in this study is that adults with autism who work in competitive employment for an extended period of time (3 years) show a greater rate of improvement in several cognitive variables, replicating the findings in other studies that found improvement in some of the same non-vocational domains Drake *et al.* 2003). That is, this study offers preliminary support for the view that competitive employment elicits positive cognitive changes outside the work domain. As the control group showed no change in performance over time, our results indicate a positive effect of working on cognitive performance, rather than an impairment in performance as a result of not working.

This study has several limitations: the small number of participants, the relatively short time of the community employment, the non-consideration of individual differences in demographic and clinical variables, etc. But these limitations aside, this study demonstrated that, for people with autism, the supported employment has a positive influence on cognitive variables. Perhaps the best way to determine the possible impact of work on non-vocational results is to analyse a pattern of results over a series of studies.

Acknowledgements

This paper was supported by Grants of Fondo Social Europeo and Consejería de Asuntos Sociales de la Comunidad Autónoma de Madrid. Our thanks to Carmen Muela, Jennifer Soro and the therapists of Association Nuevo Horizonte (Madrid).

References

American Psychiatric Association (1994) *Diagnostic and Statistical Manual for Mental Disorders*, 4th edn. (DSM-IV). Author, Washington, DC.

Anderson V. (1998) Assessing executive functions in children: biological, psychological, and developmental considerations. *Neuropsychological Rehabilitation* **8,** 319–49.

Bell M., Bryson G., Greig T., Corcoran C. & Wexler B. E. (2001) Neurocognitive enhancement therapy with work therapy, effects on neuropsychological test performance. *Archives of General Psychiatry* **58,** 763–8.

Bellak A. S., Gold J. M. & Buchanan R. W. (1999) Cognitive rehabilitation for schizophrenia: problems, prospects, and strategies. *Schizophrenia Bulletin* **25,** 257–74.

Bennetto L. (2002) Evaluación y tratamiento de las funciones ejecutivas en el autismo. In: *El Autismo En la Vida Adulta [The Autism in the Adult Life]* (ed. D. García-Villamisar), pp. 217–53. Promolibro, Valencia, Spain.

Berg E. A. (1948) A simple objective technique for measuring flexibility in thinking. *Journal of General Psychology* **39,** 15–22.

Black B. J. (1988) *Work and Mental Illness: Transitions to Employment*. Johns Hopkins Press, Baltimore, MD.

Brophy M., Taylor E. & Hughes C. (2002) To go or not to go: inhibitory control in 'hard to manage' children. *Infant and Child Development* **11,** 125–40.

Burgess P. W. (1997) Theory and methodology in executive function research. In: *Methodology of Frontal and Executive Function* (ed. P. Rabbit), pp. 81–117. Psychology Press, Hove.

Drake R. E., Becker D. & Bond G. R. (2003) Recent research on vocational rehabilitation for persons with severe mental illness. *Current Opinion in Psychiatry* **16,** 451–5.

Fuster J. M. (1997) *The Prefrontal Cortex: Anatomy, Physiology and Neuropsychology of the Frontal Lobe*, 3rd edn. Raven Press, New York.

García-Villamisar D. (2000) *El Empleo con Apoyo para Personas con Autismo [The Supported Employment for People with Autism]*. Promolibro, Valencia, Spain.

García-Villamisar D. (2002) Diagnóstico y clasificación del autismo. In: *El Autismo en la Vida Adulta [The Autism in the Adult Life]* (ed. D. García-Villamisar), pp. 97–123. Promolibro, Valencia, Spain.

García-Villamisar D. & Della Sala S. (2002) Dual-task in adults with autism. *Cognitive Neuropsychiatry* **5,** 139–56.

Gold J. M., Qeern C., Iannone V. N. & Buchanan R. W. (1999) Repeatable Battery for the Assessment of Neuropsychological Status as a screening tests in schizophrenia, I: sensitivity, reliability, and validity. *American Journal of Psychiatry* **156,** 1937–50.

Gold J. M., Goldberg R. W., McNary S. W., Dixon L. B. & Lehman A. F. (2002) Cognitive correlates of job tenure among patients with severe mental illness. *American Journal of Psychiatry* **159,** 1395–402.

Happé F. (1999) Autism: cognitive or cognitive style? *Trends in Cognitive Sciences* **3,** 216–22.

Hill E. (2004a) Executive dysfunction in autism. *Trends in Cognitive Sciences* **8,** 26–32.

Hill E. (2004b) Evaluating the theory of executive dysfunction in autism. *Developmental Review* **24,** 189–233.

Hobson P. (1991) Methodological issues for experiments on autistic individual's perception and understanding of emotion. *Journal of Child Psychology and Psychiatry* **32,** 1135–58.

Hughes C. & Graham A. (2002) Measuring executive functions in childhood: problems and solutions? *Child and Adolescent Mental Health* **3,** 131–42.

Hughes C., Russell J. & Robbins T. W. (1994) Evidence for executive dysfunction in autism. *Neuropsychologia* **32,** 477–92.

Hughes C., Leboyer M. & Bouvard M. (1997) Executive function in parents of children with autism. *Psychological Medicine* **27,** 209–20.

Hughes C., Plumet M.-H. & Leboyer M. (1999) Towards a cognitive phenotype for autism: increased prevalence of executive dysfunction and superior spatial span amongst siblings of children with autism. *Journal of Child Psychology and Psychiatry* **40,** 1–14.

Kagan J. (1966) Reflection-impulsivity: the generality and dynamics of conceptual tempo. *Journal of Abnormal Psychology* **71,** 17–24.

Kagan J., Rosman B., Day D., Albert J. & Phillips W. (1964) Information processing in the child: significance of analytic and reflective attitudes. *Psychological Monographs* 78 (monographic edition).

Lehto J. E., Juujärvi P., Kooistra L. & Pulkkinen L. (2003) Dimensions of executive functioning. Evidence from children. *British Journal of Developmental Psychology* **21,** 59–80.

Miller E. (1984) Verbal fluency as a function of a measure of verbal intelligence and in relation to different types of pathology. *British Journal of Clinical Psychology* **23,** 53–7.

Milner B. (1971) Interhemispheric differences in the localization of psychological process in man. *British Medical Bulletin* **27,** 272–7.

Miyake A., Friedman N. P., Emerson M. J., Witzki A. H., Hoverter A. & Wagner T. D. (2000) The unity and diversity of executive functions and their contributions to complex 'Frontal lobe task': a latent variable analysis. *Cognitive Psychology* **41,** 49–100.

Owen A. M., Stern C. E., Look R. B., Tracey I., Rosen B. R. & Petrides M. (1998) Functional organization of spatial and nonspatial working memory processing within the human lateral frontal cortex. *Proceedings of the National Academy of Sciences of the USA* **95,** 7721–6.

Ozonoff S. (1997) Components of executive function in autism and other disorders. In: *Autism as an Executive Disorder* (ed. J. Russell), pp. 179–215. Oxford University Press, Oxford.

Ozonoff S., Cook I., Coon H., Dawson G., Joseph R. M., Klin A., McMahon W. M., Minshew N., Munson J. A., Pennington B. F., Rogers S. J., Spence M. A., Tager-Flusberg H., Volkmar F. R. & Wrathall D. (2004) Performance on Cambridge Neuropsychological Test Automated Battery subtests sensitive to frontal lobe function in people with autistic disorder: evidence from the collaborative programs of excellence in autism network. *Journal of Autism and Developmental Disorders* **34,** 139–50.

Reitan R. M. & Wolfson D. (1993) *The Healsted-Reitan Neuropsycholgical Test Battery: Therapy and Clinical Interpretation*. Neuropsychological Press, Tucson, AZ.

Robbins P., James M., Ovwen B. J., Sajakian L., McInnes L. & Rabbitt P. (1997) A neural systems approach to the cognitive psychology of ageing using the CANTAB battery. In: *Methodology of Frontal and Executive Function* (ed. P. Rabbit), pp. 215–38. Psychology Press, Hove.

Schopler E., Reichler R. J. & Renner B. R. (1988) *The Childhood Autism Rating Scale (CARS): For Diagnostic Screening and Classification of Autism*. Irvington, New York.

Turner M. (1997) Towards an executive dysfunction account of repetitive behaviour in autism. In: *Autism as*

an Executive Disorder (ed. J. Russell), pp. 57–100. Oxford University Press, Oxford.

Wehman P. (2000) Introducción. In: *El Empleo Con Apoyo para Personas con Autismo [The Supported Employment for People with Autism]* (ed. D. García-Villamisar), pp. 1–10. Promolibro, Valencia, Spain.

Whold Health Organization (2003) *The ICD-10 Classification of Mental and Behavioral Disorders: Clinical Descriptions and Diagnostic Guidelines.* Tenth Revision. Clinical Modification. Pre-release Draft. WHO, Geneva, Switzerland.

Wing L. (2002) Adultos con autismo. Una breve perspectiva histórica. In: *El Autismo en la Vida Adulta [The Autism in the Adult Life]* (ed. D. García-Villamisar), pp. 33–53. Promolibro, Valencia, Spain.

Accepted 2 March 2006