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Postsecondary University Education Improves Intelligence of Adult Students with Intellectual Disability: A Preliminary Study

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ABSTRACT

This follow-up study aimed to examine (a) the impact of 4.5 years participation in postsecondary education (PSE) on students with intellectual disability (ID) compared to adults with ID who did not participate in PSE, (b) whether a different impact on crystallized and fluid intelligence after 4.5 years would be found among PSE students with higher and lower initial IQ, (c) micro-level individual differences in each PSE group. The WAIS-III was administered at Time 1 and after 4.5 years to PSE students in an inclusive full requirements model (n = 6; IQ = 66-72) and to the PSE students in the inclusive adapted requirements model (n = 6; IQ = 54 -61) and adults with ID who did not participate in the PSE (n = 12). Only PSE students showed improvement in FSIQ, verbal and performance IQ in this Time 2 evaluation, with individual differences between the students. FSIQ and verbal IQ of students with a higher IQ exceeded the diagnostic cutoff of ID (IQ < 70-75). Despite the small sample size, the findings indicate that time extension and mediation strategies enable adults with mild ID to achieve academic goals, thus, supporting the Compensation Age and the Mastery Learning theories.

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Postsecondary academic education; adults with intellectual disability; initial higher/lower IQ; verbal/performance intelligence; individual differences

PSE programs for adults with ID: models and outcomes

PSE programs for students with intellectual disability (ID) are on rise around the world (Lee and Taylor 2022). There are 310 colleges and university programs in the USA. Contents are varied, and include education, independent living, vocational/career and academic programs (Grigal et al. 2022; Rayen et al., 2019). In Think College (Grigal et al. 2022) and at the University of Alberta in Canada (Uditsky and Hugson 2012), students with ID attend selected undergraduate courses in business, education, communication, sociology, or complete segregated courses tailored to their level.

Lee and Taylor (2022) reviewed the benefit of PSE programs for students with ID. Ryan et al. (2019) found improvement in independent living skills after completing PSE programs in Australia. Positive employment outcomes after completing a PSE program were expressed by higher employment rates, employment positions, hours, and wages. Improvement was found in self-esteem, self-determination, self-confidence, and social

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participation among PSE students with ID in Ireland (Spassiani et al. 2017). Students reported on their self-perceived intellectual and learning growth following PSE programs (Corby, Taggar, and Cousines 2020). However, the above studies are based on qualitative semi-structured interviews of the students, their mentors and their parents (Lee and Taylor 2022). There is a need for statistical data (Duke et al., 2017) on the contribution of PSE to cognitive outcomes of students with ID, beyond their subjective feeling of intellectual growth. This study fills this void.

Effects of higher education on the intelligence of students with typical development

Intelligence is a general mental capability. It includes reasoning, planning, problem solving, abstract thinking, learning from experience (Gottfredson, 1997). This study does not go into definitions. Rather, it uses intelligence as a measure according to Horn and Cattell (1966), Kaufman (2001) and McGrew (2009).

Crystallised intelligence (*Gc*), measured by verbal IQ, refers to acquired cultural and linguistic knowledge – a 'maintained' ability that increases into one's sixties and seventies in the general population and then declines (Góngora et al. 2020; Kaufman 2001). *Fluid* intelligence (*Gf*), measured by performance IQ, refers to deliberate mental problem-solving operations – a 'vulnerable' ability that peaks in the early twenties in the general population and then declines (Kaufman 2001).

In the general population, researchers focused on the effect of higher education as a cause for improving *Gc* and *Gf*. Clouston et al. (2012) found that completing a university education was linked to higher midlife fluid abilities measured by the Weschler WAIS. Other studies (Moehring, Schroeders, and Wilhelm 2018; Trapp et al., 2019) reported education effects on crystallised knowledge such as verbal memory, vocabulary and verbal fluency. Ackerman (2000) found that advanced academic degrees correlated more strongly with *Gc* (Ph.D. graduates surpassed MA graduates who surpassed BA graduates). This was non-significant for *Gf*. *Gc* demonstrated considerable explanatory power in predicting students' knowledge in social sciences, whereas fluid intelligence predicted knowledge in exact sciences.

PSE empowerment project for students with ID

This study examined the impact of PSE on 12 students with mild ID who study in a university-based program at the Bar-Ilan University Faculty of Education. The Empowerment Project is derived from United Nations (2006) convention which calls for ensuring accessibility of persons with disabilities *'to general tertiary education, vocational training, adult education and lifelong learning without discrimination'* (United Nations 2006, 20). The Empowerment Project is anchored in the Compensation Age Theory (Lifshitz 2020) and the Structural Cognitive Modifiability Theory (Feuerstein 2003). It aims to promote knowledgeable, intelligent, motivated students with ID and develop their cognitive and social-emotional growth. The Project includes three models of inclusion:

Separate adapted enrichment model: Students with mild ID attend the Bar-Ilan University Faculty of Education once a week for four academic courses adapted to their level (Developmental Psychology, Sociology, Geography, Self-Advocacy). **Inclusive**

adapted requirements model: In the second year, students with ID are integrated in undergraduate courses of typical students. They audit the courses. The academic requirements, class tasks and examinations are adapted to their level. **Inclusive full requirements model**: Students with ID are integrated into the same undergraduate courses as in the inclusive adapted requirements model, but fulfill all academic requirements, including exams and class tasks (see details in the Method section).

In conclusion, scientists examined the impact of university studies on the intelligence of students with typical development (TD) (Ackerman 2000; Clouston et al., 2012). PSE studies on students with ID focused on social, employment and adaptive behaviour outcomes. The question of whether PSE has a similar effect on intelligence of these students, as was found for students with TD, might shed light on the application of the Cognitive Reserve (Stern 2012) and Environmental Enrichment theories (Kentner et al. 2019) in adults with ID.

Murray, McKenzie, and Murray (2014) found correlations between the *g* factor and the conceptual, social and practical domains of adaptive behaviour. As *g* increased, so did adaptive behaviour. Demonstrating improvement in intelligence as a result of participation in a PSE program might have a side effect of strengthening intelligence and adaptive behaviour. Furthermore, participation in cognitive activities during midlife might protect and slow cognitive decline in the future among adults with TD (Wilson and Bennett 2003; with ID (Lifshitz 2020).

This pioneering study investigated a rare sample: 12 adults with mild ID who persevered in the PSE inclusive model in academic courses over a 4.5-year period. Our macro- and micro-level analyses aimed to deepen the understanding of the whole-group and multiple-subject findings (Ganz and Ayres 2018), which are utilised to assess intervention outcomes for persons with disabilities in educational, medical, and clinical settings.

Goals and hypotheses

(a) To examine whether differences in FSIQ scores will be found between adults with ID who participated in PSE for 4.5 years versus adults with ID who did not participate in PSE. Systematic intervention programs improved crystallised and fluid cognitive abilities of adults with ID (Lifshitz and Rand 1999; Lifshitz et al., 2011). We hypothesised that students with ID will be able to capitalise on their PSE participation and will exhibit improvement in FSIQ from Time 1 to Time 2, compared to those who did not participate. (b) To examine whether differences in improvement will be found between verbal-crystallised and performance-fluid intelligence among students with ID in the inclusive adapted requirements model (students with a relatively lower IQ) and the inclusive full requirements model (students with a relatively higher IQ). We hypothesised an increase in FSIQ and *Gc* measures from Time 1 to Time 2 among students with ID in both models (higher/lower IQ). No prediction was made for pre-post improvement in fluid intelligence measures due to the mixed results on the effects of higher education on typical students (Ackerman 2000; Clouston et al. 2012). (c) To examine micro-level individual differences in each PSE model.

Method

Developmental milestones of the empowerment project

All 12 students followed the same path in the adapted enrichment model that started in the October 2014-June 2015 academic year. Participation in this model served as preparation for the inclusive model. We did not administer an intelligence test at the beginning of the program in order to preclude biases. In the October 2015 academic year, 15 students with ID were integrated in undergraduate academic courses in social sciences with the typical students. October-December 2015 was devoted to constructing individual tailored mediation for each student. We encouraged all students to fulfill the academic requirements. However, only 6 students with ID decided to go for it. Six did not want to. We gave them simple adapted tasks and examinations in each course. Fulfilling basic academic requirements was a condition for participation in the inclusive adapted model. Three students could not meet even the simple requirements (started to cry, copied the homework from their friends). They were excluded from the inclusive model and returned to the adapted enrichment model.

Two inclusive models were created, which were dictated by the students with ID themselves: Inclusive with adapted requirements and inclusive with full academic requirements. In January-February 2016, three months after assignments to the inclusive models, we administered the WAIS (Time 1). Significant differences were found in the initial IQ level in the inclusive adapted requirements model (MIQ = 58.00; SD = 2.37) versus the inclusive full requirements model (MIQ = 67.17; SD = 2.56). Despite the differences in the initial IQ level between the two inclusive models, we provided the same amount and quality of mediation to both groups. The WAIS was readministered (Time 2) after 4.5 years in July-August 2020. The non-PSE adults were tested in 2016 (Time 1) and 4.5 years later in January 2020 (Time 2). Table 1 summarises the milestones of the PSE program and this study.

Inclusion criteria for the adapted enrichment model: Adults with moderate-mild ID (according to the DSM-5, 2013), with basic reading and writing skills, independent in Activities of Daily Living, without maladaptive behaviour (based on the report of parents or professional staff in their residence). No screening test was administered at this stage.

Inclusion criteria in the two inclusive models were determined after three months of integration in the undergraduate courses and were based on the WAIS assessment (Time 1).

Inclusion criteria for the inclusive adapted requirements model: FSIQ>50 [(according to ROC analysis, a fundamental tool for diagnostic test evaluation, which indicated that this cut-off point above should be the criterion for assigning students with ID to full inclusion in undergraduate courses (Lifshitz et al. 2018)], willingness to fulfill adapted academic requirements, emotional maturity with no maladaptive behaviour.

Inclusion criteria for the full requirements model: FSIQ>66, willingness to fulfill academic requirements, emotional maturity, according to ROC analysis (Lifshitz et al. 2018).

Criteria for choosing the undergraduate courses: The project's pedagogical committee chose courses from the social sciences which are based on verbal knowledge and have content relevant to the world of adults with ID: Introduction to Special Education, Intellectual Disability, Computer Programming for Special Needs, Informal Education,

Table 1. Developmental milestones of the empowerment project and the following studies.

Academic year	Purpose	The stages
October 2014-June 2015	Assignment to the Separate adapted enrichment model which comprised preparation for the inclusion model	15 students with ID were assigned to the **Separate – adapted enrichment model** (there were more students, but only 12 persevered in the program)
October - December 2015	Inclusion in undergraduate courses	15 students were integrated in undergraduate courses accompanied by an academic facilitator with the same duration and quality of mediation. Six started to fulfill the academic requirements. Six were given simple tasks adapted to their level (3 were excluded from the inclusive models).
January February 2016	WAIS-III (2001) administration Time 1	The WAIS-III (2001) was administered to the 12 students to determine their basic cognitive level. Their FIQ ranged between 50–72. A significant difference was found between students who fulfilled the academic requirements ($N = 6$) and those who did not ($N = 6$).
January 2016-June 2020	4.5 years of participation in the inclusive models	Completing 32 credits. Students in the adapted requirement model received a certificate of participation. Those in the full requirements model received 32 academic credits
July-August 2020.	WAIS-III (2001) administration Time 2	The WAIS-III (Kaufman 2001) was administered to the 12 students to determine whether improvement occurred between the two time points.
2016	FSIQ data of the non-PSE group, Time 1	FSIQ scores of 12 adults with ID (matched to the PSE group according to age, IQ, gender and aetiology) were taken from their personal files (Division of Disability, Ministry of Welfare and Social Services).
June 2020	FSIQ data of the non-PSE group, Time 2	FSIQ scores at the second examination were taken from their files.

Judaism. The courses deal with special and informal education, the rationale and values of leisure activities, the residence framework for individuals with disabilities, Jewish humanistic values and their implications for everyday life which strengthen their self-efficacy to cope with these courses. Then they took courses in other departments: Mass Communication, Sociology, Art, etc. They participated in the course actively and shared their life experience as persons with disability. The lecturers of these courses received explanations about persons with ID, but continued to teach the courses as usual.

Student-focused support: The students in both models were accompanied by academic facilitators (graduates of the MA program in ID). They received an additional academic hour of mediation for each academic hour in the university course. The academic facilitator received the curriculum and content from the lecturers before the course. A reader was composed for each course, which included relevant reading materials. The mediation was directed towards promoting resourceful and knowledgeable students, strengthening their crystallised and fluid skills and their personal-social abilities. The support was conducted by a team of six persons for each model. Additional tailored mediation was given according to need.

Concept of mediational strategy: The academic material was adapted and adjusted to the students by the academic facilitator using three key strategies: The Universal Design

of Learning (UDL, Israel et al., 2014), the new Bloom taxonomy (Forehand 2010; language simplification (Department of Health 2010).

UDL provides three main principles for learning: (a) Multiple means of representation, aiming to promote resourceful, knowledgeable students and strengthen comprehension, language, perception, expression and communication which represents verbal-crystallised skills. The academic facilitators work with the students on reading comprehension (identification of titles, new words, key words, distinguishing between principal and secondary ideas, asking and answering questions). We used Easy to Read principles for making written information easier to understand for people with learning disabilities (Department of Health 2010). (b) Multiple means of action aiming to promote strategic, goal-directed students, strengthening working and long-term memory and executive function, and self-regulation which represents fluid skills. Bloom's taxonomy (Forehand 2010) is also used, with adaptation to populations with ID. The academic materials (texts, PowerPoint presentations) were analysed for remembering, comprehension, application, analysis, synthesis, and evaluation. (c) Means of engagement, strengthening motivation and persistence and coping resources.

Criteria of success: In the *inclusive adapted requirements model*: fulfilling basic academic requirements. Instead of multiple-choice examinations, students received open-ended questions and simple class tasks. Fulfilling the requirements was a criterion of success. In some courses of the *inclusive full requirements model*, the final score is determined by exams and in some, by course tasks. The criteria required of the students with ID were the same as those required from the students with TD. In Israel, exam scores range between 0–100, with a passing score of 60. Some of the exams are multiple-choice, which are difficult for students with ID. We developed a method for coping with these tests. In courses in which there were no exams, the final score is comprised of course assignments. Course work scores are comprised of strict criteria of expressive writing ability, using scientific terms, and reading academic articles. The same criteria are used for the students with ID. The scores of the students with ID ranged between 60–80. They have so far earned 32 academic credits.

The current study

Participants

The current sample included 24 participants, divided into students with ID who participated in the PSE Empowerment Project (PSE group: $n = 12$), and adults with ID with the same background, who did participate in the PSE (non-PSE group: $n = 12$).

PSE groups

Administration of the WAIS at Time 1 indicated differences in the initial IQ in the two inclusive models: $n = 6$; MIQ = 58.00; $SD = 2.37$; $n = 6$; MIQ = 69.17; $SD = 2.56$ for the students in the inclusive adapted and full requirements models, respectively.

Non-PSE group

The adults in the non-PSE group were matched to the participants in the PSE program according to chronological age (CA = 25–51), gender, aetiology, and IQ (range 54–72).

Data on FSIQ of the non-PSE adults were obtained from their personal files in the Division of Disability, the Ministry of Welfare and Social Services, which administers the WAIS every 4.5 years. Only adults with the above characteristics, with two WAIS assessments 4.5 years apart, participated in the research.

Chronological age

Chronological age of the PSE group: *M*CA = 35.62, *SD* = 6.81; range = 25–51 and the non-PSE group: *M*CA = 37.10, *SD* = 9.80; range = 28–51, with no significant difference between the groups, $F(1,48) = .36$, $p = .55$, $\eta_p^2 = .01$.

IQ at Time 1: Adults in the non-PSE group were matched to the PSE group according to IQ scores at Time 1, with no significant difference between participants with higher IQ in the two groups (*M*IQ = 69.17; *SD* = 2.56; *M*IQ = 67.33; *SD* = 2.94 for the PSE and non-PSE groups, respectively; $t(10) = 1.15$, $p = .277$); and participants with lower IQ (*M*IQ = 58.00; *SD* = 2.37, *M*IQ = 58.50: *SD* = 3.67 for the PSE and non-PSE groups, respectively; $t(10) = .28$, $p = .785$).

Gender

The sample included 58% ($N = 14$) women and 42% ($N = 10$) men, with no significant differences in gender distribution between the PSE/non-PSE groups, χ^2 (1) = .34, $p = .558$.

Aetiology

Of the participants ($N = 24$), 10 (42%) have non-specific ID, 8 (33%) have Down syndrome, 2 (8.3%) have William syndrome and 4 (17%) have mild emotional disturbance, with no significant differences in aetiology distribution between the PSE and non-PSE groups, χ^2 (1) = 1.03, $p = 31$.

Residence

Half of the participants live in community residences for adults with ID under the supervision of the Government Division of Intellectual Disability of the Ministry of Welfare and Social Affairs, and half live at home with parents.

All participants worked mornings in vocational centres or various workplaces, and attended afternoon leisure activities. Leisure activities of both groups include table games, watching TV, reading, using technological devices, and various courses in community centres. The PSE students attended university courses twice weekly. The adults in both groups have a similar background, except for participation of 12 students with ID in the PSE Empowerment Project. Table 2 presents the background characteristics of the PSE/non-PSE groups.

Intelligence measures

Crystallised and fluid intelligence were examined by the Wechsler Intelligence Test for Adults, WAIS-III III^{HEB} (Wechsler 2001). The Verbal IQ tests included the Vocabulary,

Table 2. Demographic characteristics according to gender, age, aetiology, and IQ scores (WAIS-III) of the PSE ($N = 12$) and non PSE ($N = 12$) groups.

					FSIQ			Verbal IQ			Performance IQ		
Grp	Student	Sex	Age (yrs.)	Etiology/ disability	Time 1	Time 2	Change	Time 1	Time 2	Change	Time 1	Time 2	Change
Higher IQ	A PSE	F	34.0	Down	66	82	16	77	92	15	59	73	14
	A Non PSE	F	36.0	Down	65	65							
	B PSE	F	36.0	Down	67	75	8	67	80	13	73	73	0
	B Non PSE	F	35.0	Down	65	65							
	C PSE	F	27.7	NSE/Psych.	68	65	−3	72	72	0	69	62	−7
	C Non PSE	F	28.0	NSE/Psych.	64	60							
	D PSE	F	25.9	Williams	70	84	14	81	92	11	63	75	12
	D Non PSE	F	27.0	Williams	70	68							
	E PSE	M	25.7	NSE/Phys.	72.0	85	13	81	90	9	65	80	15
	E Non PSE	M	27.0	NSE	70	69							
	F PSE	M	25.9	Down	72	91	19	73	95	22	76	89	13
	F Non PSE	M	27.0	Down	70	70							
	G PSE	M	30.0	Williams	54	61	7	58	63	5	58	65	7
	G Non PSE	M	30.0	Williams	54	54							
	H PSE	M	28.5	Down	57	60	3	58	63	5	53	63	10
	H Non PSE	M	30.0	Down	58	58							
	I PSE	F	29.5	NSE	58	72	14	59	74	15	65	74	9
	I Non PSE	F	30.0	NSE	60	60							
Lower IQ	J PSE	F	51.0	NSE	59	69	10	61	67	6	64	77	13
	J Non PSE	F	51.0	NSE	60	58							
	K PSE	M	41.0	NSE	59	65	6	65	69	4	59	65	6
	K Non PSE		40.0		56	56							
	L PSE	F	30.0	NSE	61	62	1	61	62	1	69	69	0
	L Non PSE	F	30.0	NSE	63	63							

PSE-Post secondary group; Non PSE-adults with ID who did not participate in PSE; NSE=non-specific ID.
Note. Psych.=psychiatric disorders; Phys.=physical disability; Change=Time 2 minus Time 1 scores; positive values indicated improvement.

Similarities, Comprehension, Arithmetic, Digit Forward/Backward, Letter-Number subscales. Performance IQ included Picture Completion, Pictures Arrangements, Block Design, Matrix, Coding, Signs subscales. Administration and scoring were conducted according to the manual.

Procedure

Ethical procedures

Authorizations were obtained from the Faculty of Education Ethics Committee and the Israel Ministry of Welfare's Disability Division. Participants' parents/guardians signed written consents. Students with ID signed easy-to-read consents. We orally clarified that there was no obligation to participate. Per the normalisation principle, all participants chose a gift or payment at each time point. WAIS-III^{HEB} testing was administered individually (~90 min) by the Chief Psychologist of the Ministry of Welfare's Disability Division.

Data analysis

Shapiro-Wilk tests indicated that the dependent variables in the PSE/non-PSE groups did not have a normal distribution ($p < .05$). We therefore conducted non-parametric as well as parametric analyses. The Wilcoxon tests examined differences between the two time points in each group and the Mann-Whitney test examined differences between the two PSE groups at each time point. The findings and significance level of the non-parametric analyses matched those of the parametric analyses. We therefore used the parametric analyses.

We restricted the α error and considered the main effects and the interaction to be significant only at $\alpha < .01$. When the main effect or the interactions were significant only at $\alpha < .05$, the results were considered as marginally significant and were regarded with caution in the Discussion.

Results

A three-way mixed ANOVA (2×2x2) was conducted with Group (PSE/non-PSE) and level of intelligence at Time 1 (higher/lower) as between-subject factors and Time (before-Time 1, after-Time 2) as the within-subject factor to test Hypothesis 1: differences between the two PSE groups and the two matched non-PSE groups in the FSIQ on the WAIS test (Figure 1).

The main effects of Time, Group and Level of Intelligence were significant [$F(1,20) = 21.87$, $p < .001$, $\eta_p^2 = .52$, $F(1,20) = 13.28$, $p = .002$, $\eta_p^2 = .40$ and $F(1,20) = 49.30$, $p < .001$, $\eta_p^2 = .71$, respectively]. Performance on the FSIQ was higher at Time 2 compared to Time 1. At Time 2, the performance of the PSE group was significantly higher compared to the non-PSE group. Participants with a higher IQ performed better than those with a lower IQ.

The Time X Group interaction was significant, $F(1,20) = 31.50$, $p < .001$, $\eta_p^2 = .61$. Paired samples *t*-tests comparing the two time points were conducted for each group (PSE/non-PSE) to examine the source of the interaction. The results indicated that while the PSE group significantly increased their FSIQ score at Time 2 compared to Time 1 [$t(11) = 5.08$,

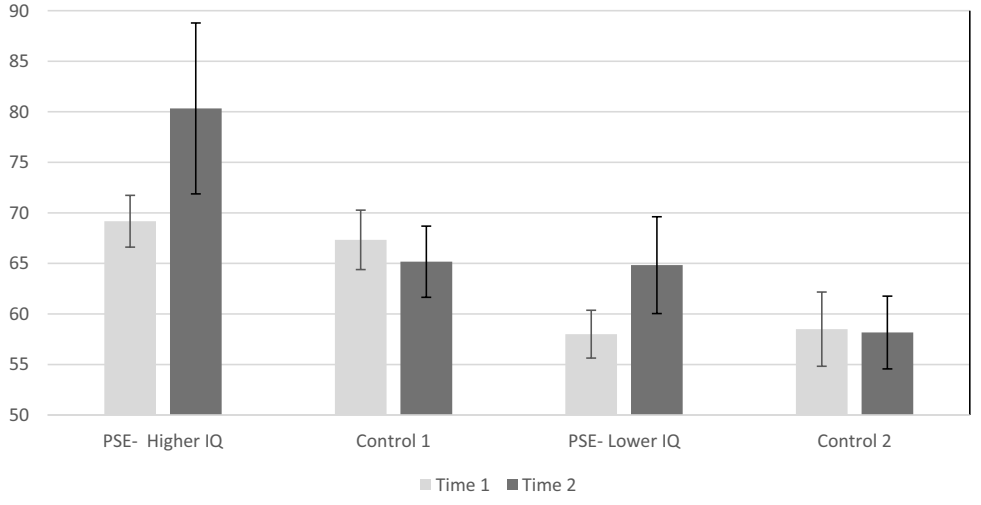

Figure 1. Differences between the PSE/non PSE groups according to intelligence level on the WAIS-III FSIQ test.

$p < .001$ and $t(11) = 2.16$, $p = .054$, for participants with higher/lower IQ, respectively], the participants in the non-PSE group exhibited a slight non-significant decrease in their FSIQ performance.

The two-way interactions of Time X Level of Intelligence and Group X Level of Intelligence, and the three-way interactions of Time X Group X Level of Intelligence were non-significant [$F(1,20) = 1.06$, $p = .316$, $\eta_p^2 = .05$, $F(1,20) = 2.76$, $p = .112$, $\eta_p^2 = .12$ and $F(1,20) = 2.53$, $p = .127$, $\eta_p^2 = .11$, respectively].

Difference between PSE students with higher/lower IQ

Two-way mixed ANOVAs were conducted to examine differences between the two time points among the two PSE groups (higher/lower IQ) in the FSIQ, verbal IQ and performance IQ scales (Table 3).

The main effects of Time were significant for all three IQ measures, with significantly higher IQ scores at Time 2 compared to Time 1. The main effects of Group were also significant for the FSIQ score and for the verbal IQ score, with higher IQ scores of the higher IQ group compared to the lower IQ group. Time X Group interactions were non-significant. Both groups increased their IQ scores from Time 1 to Time 2.

Micro-level analyses

We examined micro-level data for individual students in each group. For four students with higher IQ in the inclusive requirements model (A, D, E, F), FSIQ and verbal (crystallised), IQ scores at Time 2 improved such that they exceeded the cut-off point for ID (IQ = 70–75; Table 2), and student B reached IQ = 75. Only student C, who has mild emotional problems, exhibited decline. For performance IQ (fluid intelligence), students E and

Table 3. Mean, SD, Median (Mdn) and range of the WAIS IQ tests among PSE participants according to level of intelligence [Higher IQ ($n = 6$) and Lower IQ ($n = 6$) groups].

		Time 1			Time 2			*p-values* (η_p^2)		
Measures	Intelligence Level	*M*	*SD*	*Range*	*M*	*SD*	*Range*	Time	Group	Time×Group
FSIQ	Higher IQ	69.17	2.56	66–72	80.67	8.45	65–91	27.68***	31.17***	1.79
	Lower IQ	58.00	2.37	54–61	64.83	4.79	60–72	(.74)	(.76)	(.15)
Verbal IQ	Higher IQ	75.17	5.53	67–81	86.83	8.91	72–95	24.95***	37.11***	2.57
	Lower IQ	60.33	2.66	58–65	66.33	4.63	62–74	(.71)	(.79)	(.20)
Performance IQ	Higher IQ	67.50	6.38	59–76	75.33	8.91	62–89	13.77**	3.61	.01
	Lower IQ	61.33	5.75	53–69	68.83	5.60	63–77	(.58)	(.27)	(.00)

$p < .01$.*$p < .001$.

F exceeded the ID diagnostic cut-off, students A, B, and D remained in the IQ range of 70–75, and student C deteriorated.

In the group with an initial lower IQ, data at Time 2 revealed clear improvement patterns. However, only one student's performance IQ score (student J) exceeded the cut-off (Table 2). Student I was the only one in the lower IQ group who scored within the 70–75 range.

Discussion

The complementary macro- and micro-level analyses of the impact of 4.5 years of participation in PSE on intellectual functioning of adults with ID will be at the core of the discussion.

The findings indicate significant improvement in the WAIS-III FSIQ after 4.5 years participation in PSE among 12 adults with ID compared to adults with ID with the same intelligence level and lifestyle who did not participate in PSE. At the macro level, after 4.5 years of integration in undergraduate courses, the FSIQ, verbal (*Gc*) and performance (*Gf*) intelligence of the students who participated in the PSE program in the two inclusive models improved their scores to the same extent. The micro-analysis showed that the FSIQ and verbal IQ scores of several students with an initial higher IQ (in the inclusive full requirements model) increased beyond the diagnostic cut-off of ID.

Impact of PSE on intelligence – pretest versus posttest after 4.5 years

The findings indicated improvement in FSIQ after 4.5 years only among the PSE group, compared to adults in the non-PSE group with the same lifestyle, except for participation in the PSE Empowerment Program. Similarly to typical students (Ackerman 2000; Clouston et al. 2012), our study is the first to indicate the cognitive and intellectual benefits of a PSE program for adults with ID, beyond adaptive behaviour, social and employment aspects (Lee and Taylor 2022). Our longitudinal findings indicate that higher education accompanied by systematic mediation is a cause of enhancing intelligence in the population with ID, thus supporting Hypothesis 1.

The gains in the FSIQ of adults with ID following the PSE program support the Compensation Age Theory, according to which adults with ID can benefit from mediation even at advanced age as they accumulate life experiences (Lifshitz 2020).

Cognitive reserve refers to a compensatory mechanism that helps people cope with pathological life events (Stern 2012). One might argue that individuals with ID exhibit lower cognitive reserve due to their lower level of intelligence and fewer opportunities for cognitive education and cognitive leisure activities compared to the general population. In light of our findings, it can be said, with caution due to the small sample size, that under certain systematic strategic mediation support and time extension, students with ID are able to actively participate in undergraduate academic learning and achieve academic goals.

Impact of PSE on intelligence

Both students with an initial higher and lower IQ improved their FSIQ, verbal-crystallised and performance-fluid intelligence. Participation in PSE helped them consolidate cultural and linguistic crystallised knowledge, thus supporting Hypothesis 2. Our findings correlate with studies that found effects of higher education on crystallised knowledge (Moehring, Schroeders, and Wilhelm 2018) and on fluid-performance intelligence (Kyröläinen and Kuperman 2021). *Gf* also improved from Time 1 to Time 2. *Gf* is interpreted as the capacity to solve novel, complex problems using operations such as inductive and deductive reasoning, concept formation, and classification and is associated with *general intelligence g* (Kvist and Gustafsson 2008; Spearman 1927). The change in IQ scores from Time 1 to Time 2 was not only an acquired change expressed by the *Gc*, but a more structural change expressed by fluid intelligence (*Gf*).

The superiority of the students with higher IQ at Time 1 was expressed in the FSIQ as well as in the crystallised verbal intelligence, which is culture-dependent, but not in *Gf*. At Time 2, the two-way ANOVA indicated a main effect for group, but the Time X Group interaction was non-significant. Thus, both higher/lower IQ groups gained from participation in PSE in the verbal and performance subscales. However, students with higher IQ maintained their advantage. Their FSIQ and verbal (crystallised) IQ increased and exceeded the diagnostic cut-off of ID according to the DSM-5 (2013). For students with lower IQ, participation in PSE improved their verbal IQ, but they remained within the mild ID range.

What was the mechanism for their success? Bloom (1981; McGaghie, 2015) defined **mastery learning** as a set of teaching and learning strategies based on the premise that students will achieve a high level of understanding in a given domain **under two conditions: enough time** and **efficient strategies**. The PSE Empowerment Project is the first to apply *the two conditions of mastery learning* among students with ID in an academic environment. Typical students finish the BA (64 academic credits) in three years. Our students with ID learned at their own pace and finished only 32 courses in 4.5 years, where mediation and a support system were most important.

Our conceptual goal was to promote knowledgeable, intelligent, motivated and resourceful students with ID, and the ability to cope with the difficulties and challenges posed by the program. We invest in the cognitive outcomes of these students, and in mediation and support (Dukes et al. 2017. We combine three strategic methods. The first aim of the UDL (Israel, 2010) helped us promote the students' crystallised linguistic abilities, such as comprehension, language and perception, expression and communication. The academic facilitator taught the students to divide the material into small units or

paragraphs and analyse it according to titles, new words, key words and distinguish between principal and secondary ideas. We encourage them to make oral presentations. We wrote the key issues on a PowerPoint presentation accompanied by visual scaffolding according to the 'picture superiority effect' in a population with ID (Lifshitz, Kilberg, and Vakil 2016; Paivio 1986). Students with ID read the material aloud and then explain it in their own words. In line with the second goal of the UDL, the material is processed according to the five stages of Bloom's new taxonomy (Forehand 2010). Repetitions and rehearsal (Lifshitz, Kilberg, and Vakil 2016) strengthen their working and long-term memory and enable them to learn theories and abstract concepts (Lifshitz 2020; Feuerstein 2003). The academic facilitator taught them to *apply* the material to their lives, *analyse* the subtopics of the material, *synthesise* the subtopics to the main idea, and express their opinion and insight on what they learned. For achieving self-regulation and self-directedness skills, we worked on the executive function, time and material management at the university and at home, study for examinations and performing class work. These skills represent fluid skills directed towards solving mental problems. All activities and mediation in the two inclusive models were conducted in **team groups**, which help promote and strengthen the personal and social skills of the students with ID. Group meetings in which academic and social issues were discussed, as well as coping with the cognitive and emotional load of the demands and requirements, were held every two weeks. The academic facilitator encourages and supports them in difficult moments, and frames the benefits of PSE for them personally in their lives.

Feuerstein (2003) claimed that one of the characteristics of structural change is that alterations that occur in an individual's behavioural repertoire do not disappear over time. Rather, they are evident for a long period. With time, functions that were attained improve and become more efficient. This is achieved through the inherent traits of the structure, which leads to self-perpetuating behaviour requiring less investment of energy. In line with the Environmental Enrichment Theory (Kentner et al. 2019), it seems that the holistic strategies mechanism in imparting academic knowledge strengthens brain plasticity of students with ID, as expressed in improvements in their *Gc* and *Gf* as well as in FSIQ after 4.5 years.

Micro-level analysis

Our micro-level analysis is in line with Haier's (2014) recommendations suggesting that high individual variability in the higher IQ group may have precluded macro-level significance for this small sample. The higher IQ group exhibited a higher standard deviation in the FSIQ and verbal IQ, mainly at Time 2. The IQ scores of four of the six higher IQ students increased at Time 2 by 12–19 points. One student's score remained unchanged. The IQ of student C remained in the mild ID range, and she scored lower than all her peers in the higher IQ group, mainly in fluid measures. This may be attributed to her emotional challenges. Nonetheless, in crystallised intelligence, she demonstrated improvement in Vocabulary, Similarities, Information, and Digit Span. Her 5-point decline in performance IQ suggests that fluid intelligence, especially Block Design, may be more vulnerable to decline stemming from emotional problems than crystallised intelligence (Lautarescu et al., 2017). The large standard deviation in fluid intelligence of the higher IQ group could

be the reason for the lack of significance in their improvement compared to those with lower IQ.

The, individual IQ scores of six students with lower IQ increased by 6–13 points (most prominently Matrix-Reasoning). The score of student J even exceeded the ID diagnostic cut-off point. However, her other measures did not show such improvement. Only Student L in this group showed no pre-post change, and none showed decline. The mean group gain was significant (from~61 to~69).

Conclusions

It can be concluded, with caution, that PSE has a potential for improving the FSIQ (*Gc*, *Gf*) of adults with mild ID. Mediation, strategy use, and time extension can enable them to study in undergraduate courses. However, the level of intelligence is not the only crucial factor for achieving academic goals. Motivation is also important. The group with higher IQ were motivated to fulfill academic requirements. Finally, mild ID is not a uniform profile, and there are individual differences within the same IQ range. The study raises several questions: Will the students with ID (with a higher IQ) in the full requirements model be motivated to study for the remaining 32 undergraduate credits for completing their BA degree? (2) Will the IQ of the students in both models continue to grow after completing another 32 credits?

Limitations and future research

This longitudinal study investigated intelligence in a rare sample: 12 adults with mild ID who persevered in academically-oriented PSE programs over a 4.5-year period. The PSE Empowerment Project is the first of its kind in Israel. This was, therefore, the largest sample that could be found. Nevertheless, generalisation from this small sample should be made with caution. To determine whether intelligence will continue to increase, follow-up testing (Time 3) should be administered when the students in both models finish all 64 credits. This will help uncover whether individuals with ID exhibit an upper threshold for intelligence growth.

A new longitudinal design of 4 time points is recommended: upon assignment to the adapted enrichment model, assignment to the two inclusive models after 4.5 years and upon finishing the program using other cognitive measures such as working and long-term memory, linguistic skills. Emotional measures should also be examined longitudinally, as well as the impact of participation in academic PSE programs on students' adaptive behaviour. Our participants' chronological age is 28–51. Examining their intelligence at age 61 compared to the non-PSE participants could shed light on the long-term effect of our project according to the Cognitive Activity Theory (Wilson and Bennett 2003 Larger samples will permit conclusions about aetiological trends, and demographic or lifestyle factors. Qualitative interviews could further investigate PSE programs' impact on students in the above measures.

Future research comparing the impact of other PSE models (work apprentice) on intelligence and cognitive skills for adults with ID is also recommended. We compared the IQ scores of a group that has been participating in PSE for 4.5 years to those of 12 matched adults with ID who did not participate in PSE. However, the Verbal and

Performance IQs of the non-PSE group were not available. Future research should compare the Verbal and Performance IQ of PSE students and their non-PSE peers.

Educational implications

Our findings indicate that individuals with mild ID are not a single entity, and there are individual differences within the same IQ range. However, the findings indicate that academic cognitively-oriented PSE programs hold a potential for improving the intelligence of adults with ID in a wide range of IQs. These conclusions give a more colourful cast to the learning potential of adults with ID. In light of the above, academic cognitively-oriented programs should start in primary schools for pupils with ID. We suggest our CAB (Cognition, Affect and Behaviour) model (Lifshitz 2020), in which imparting adaptive behaviour skills is accompanied by strengthening basic cognitive skills, using special strategies and affect concepts even in children with lower cognitive abilities (severe/profound ID). In order to prepare the next generation of PSE students with ID, academic courses should be given at Secondary schools for adolescents with ID. PSE for adults with ID at universities and colleges should be included in the services basket provided by policy makers, and should be anchored in government legislation (Grigal et al. 2022). PSE programs should be open for adults with severe ID who need extensive support adapted to their level using special strategies. Other PSE models may include degree apprenticeships, which divide learners into traditional on-campus students and work-based apprenticeships for adults with intellectual and other disabilities.

Disclosure statement

No potential conflict of interest was reported by the authors.

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