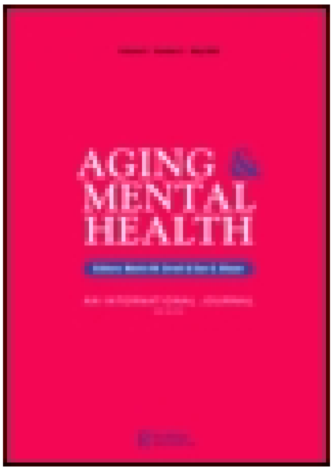

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Participation in recreation and cognitive activities as a predictor of cognitive performance of adults with/without Down syndrome

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Objective: The Cognitive Activity Theory suggests an association between participation in cognitive activities during midlife and cognitive functioning in the short term. We examined the impact of participation in cognitively stimulating activities conveyed during leisure activities on crystallized and fluid tests' performance among adults with intellectual disabilities (ID).
Method: Adults ($n = 32$; chronological age $= 25-55$) with non-specific ID and with Down syndrome rated the frequency of their participation in leisure activities. Pursuits included more cognitively involving (reading, participating in academic courses) and less cognitively involving (cooking, dancing) activities. Three judges ranked activities according to their cognitive load on a 1 (few cognitive components) to 5 (many cognitive components) points scale. The findings indicate two new scales: cognitively stimulating activities and recreational stimulating activities. The crystallized battery included phonemic fluency, synonyms, idioms, and verbal metaphors. The fluid battery included the Homophone Meaning Generation Test, Metaphoric Triad Test, Novel Metaphors Test, and Trail Making Test.
Results: Hierarchal regression with chronological and mental age, recreational, and cognitively stimulating activities indicated that participation in recreational activities contributed significantly to the explained variance of word fluency. Participation in cognitive activities contributed significantly to the explained variance of most of the crystallized and fluid tests.
Conclusions: The findings support the Cognitive Activity Theory in populations with ID. The findings also support the Compensation Age Theory: not only endogenous factors (age, etiology, IQ level), but also exogenous factors such as life style determining the cognitive functioning of adults with ID. However, frequency and the cognitive load of the activities influenced their cognitive functioning.

Keywords: intellectual disability; cognitive reserve; leisure; functioning; life style; compensation

Introduction

Although adults with intellectual disabilities (ID) have been seen as having inherently shortened life spans (largely due to lack of medical care, rehabilitation services, and poor living conditions), it is now common in most developed countries for them to live to old age (Coppus, 2013). Even adults with Down syndrome (DS) are experiencing a prolonged longevity and might reach their 70s and 80s (Chicoine & McGuire, 1997). People with ID, estimated at approximately 60 million worldwide, represent one of the largest groups of people with lifelong disabilities. As a result, because of compelling needs associated with their aging, special health, social, housing services need to be given to this segment of the world's growing elderly population.

Compensation versus stimulation interventions for delaying old age in the general population

In the general population, interest in cognitive training for delaying old age has grown significantly, leading to its implementation in hospitals, community programs, and institutions for the elderly (Mahncke et al., 2006). Kim and Kim (2014) distinguish between two types of cognitive interventions aimed at delaying aging in the general population: 'compensation-focused interventions' designed to enhance frontal mediating functions or to compensate for specific cognitive functions that are adversely affected by aging and 'stimulation-non-focused training' consisting of sensory or non-specific stimulation which is not directed toward a specific cognitive skill, but is conducted indirectly through leisure activities. Our study focuses on the second type.

One of the most influential theories in modern gerontology is the Cognitive Activity Theory (Marquinea, Segawaa, Wilson, Bennett, & Barnes, 2012; Wilson et al., 2002). This theory postulates that participation in cognitive activities during midlife has short-term and long-term effects. This participation is associated with current cognitive functioning and with reducing the risk of cognitive decline which leads to Alzheimer's disease (Wilson & Bennett, 2003; Wilson et al., 2002). Although the mechanisms underlying these associations are not well understood, cognitively stimulating activity has been posited to contribute to cognitive reserve (CR). The Cognitive

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Reserve Theory (Stern et al., 2005) postulates that individual differences in the way tasks are processed might provide a differential reserve against brain pathology or age-related changes. The viewpoint that 'the adult brain is adaptive at any age and has lifelong capacity for change' is on the rise (Mahncke et al., 2006, p. 12524). Wilson et al. (2002, 2005) constructed a scale of pursuits that is more and less cognitively stimulating. The hypothesis is that even external and novel stimuli can lead to rewiring or restoring synaptic connectivity in the brain (Kim & Kim, 2014). For instance, music or auditory stimulation might affect attention, auditory discrimination, working memory, or executive function (Kim & Kim, 2014).

Compensation versus stimulation interventions among adults with ID

In a series of studies, Lifshitz and her colleagues found that adults with ID (CA = 20−70; IQ: 40−70) can benefit from focused cognitive interventions aimed at ameliorating specific cognitive skills that are prone to decline with age, such as verbal abstraction skills, orientation in time and space (Lifshitz & Rand, 1999; Lifshitz & Tzuriel, 2004), and analogical reasoning (Lifshitz, Tzuriel, Weiss, & Tzemach, 2010).

Based on these and other studies, Lifshitz-Vahav (2015) developed the Compensation Age Theory (CAT) which comprised the following five statements. (1) Chronological age (CA) plays an important role in determining the cognitive functioning of individuals with ID, beyond their mental age (MA). Contrary to prior assumptions (Coppus, 2013), CA has a positive effect. (2) Intelligence and cognitive performance of individuals with ID might continue to grow until their 50s. (3) Adults with ID can be modified even at advanced age. (4) The positive effect of CA stems from the fact that maturity and cumulative life experience help adults with ID acquire cognitive skills that were previously absent from their behavioral repertoire. (5) Not only endogenous factors (age, etiology, IQ level), but also exogenous factors such as life style (i.e., types of leisure activities) determine their cognitive functioning. While the first four claims have been examined empirically, this study examined the impact of life style: participating in cognitively stimulating activities on the cognitive functioning of adults with ID.

The Structural Cognitive Modifiability Theory and the mediated learning experience (Feuerstein & Rand, 1974; Feuerstein, 2003), which are at the base of the CAT, postulate that the human organism is accessible to change as a result of environmental intervention, even in the presence of three formidable obstacles usually believed to prevent change: age, etiology, and severity of limitation.

The Cognitive Reserve Theory (Stern et al., 2005) also underlies the CAT. Based on the lower rate of dementia in this population (Zigman et al., 2004), our argument is that CR should be examined within the ID population, without comparison to the general population. There are individual differences in task processing among adults with ID, according to their intelligence level. However, Lifshitz and colleagues indicate that their performance might be modulated by mediation and environmental intervention. The idea of a compensation mechanism developing with increasing age in individuals with ID is also supported by genetic and brain studies. Head, Lott, Patterson, Doran, and Haier (2007) suggested that genes which are overexpressed in DS produce proteins critical for neuron and synapse growth, development, and maintenance, thus providing further evidence for the activation of plasticity mechanisms in this etiology. With aging, these genes may paradoxically participate in molecular cascades supporting neuronal compensation. Our study is the first to address the effect of participation in non-focused cognitively stimulating activities on crystallized and fluid tests among adults with ID.

Crystallized and fluid intelligence in adults with ID

McGrew (2009) redefined the Horn−Cattell model (1967) of crystallized and fluid intelligence. Crystallized intelligence is defined as 'a person's acquired knowledge of the language, information and concepts of a specific culture' (p. 5). It is associated with frontal executive function (Kaufman, 2001), working memory, analogies, and metaphor understanding. Crystallized intelligence is considered a 'maintained' ability that increases into the 60s and declines. Fluid intelligence is defined as 'the use of deliberate and controlled mental operations to solve novel problems that cannot be performed automatically' (p. 5). Fluid intelligence is a 'vulnerable' ability, peaking in the early 20s, and then declining (Kaufman, 2001). The crystallized and fluid tests used in this study can be regarded as markers for these constructs.

Research on crystallized and fluid intelligence among adults with non-specific ID (NSID) and with DS is scant. In Devenny et al. (1996), memory (which is considered a fluid test) of adults with NSID and DS improved until their 40s, and was maintained until their 50s. Contrary to the crystallized and fluid evolution in the general population, Kittler, Krinsky-McHale and Devenny (2004) found deterioration in the verbal subtests of the WISC-R over a seven-year period among adults with ID. However, Facon (2008) found a similar evolution of the Wechsler adult intelligence scale-revised (WAIS-R) verbal and performance scales among adults with NSID and DS to that of adults with typical development. These mixed results make it hard to predict differences in performance on fluid and crystallized tests between adults with and without DS. There are no reports on differences in leisure activities between these etiologies.

Our operative goals were to examine (1) the effect of participating in cognitively stimulating leisure activities on crystallized and fluid test scores of adults with ID; (2) whether different effects would be found between more cognitively involving and less cognitively involving activities. We hypothesized that frequent participation in more cognitively stimulating leisure activities would be expressed in higher performance in crystallized and fluid tests, according to the cognitive load of each activity; (3) whether different patterns of crystallized and fluid tests would be found between participants with NSID and with

DS; (4) whether differences in the crystalized and fluid tests would be found between two age groups (25−45 versus 55+).

Methods

The participants were recruited from a larger study (Shnitzer, 2015) examining the ability of adolescents and adults with ID with and without DS to acquire metaphorical language. We used the crystallized and fluid baseline scores of the adults from the larger study.

Participants

Participants with NSID ($N = 18$) and DS ($N = 14$) were recruited from residential or vocational facilities of adults with ID under the supervision of the Division of Intellectual Disability of the Israel Ministry of Welfare. Of them, 18 were males (56.3%) and 14 females (43.8%), with no significant differences between the two etiologies (χ^2 (1) = .26, $p > .05$). They met the criteria: adults with mild/moderate ID (American Psychiatric Association, 2013), independent in activities of daily living skills, without maladaptive behavior.

The age range of the participants was 25−55 (M = 40.89, SD = 8.96), without any difference between the groups, t (30) = −1.677, $p > .05$. The mean MA (Peabody Picture Vocabulary Scale, Dunn & Dunn, 1997) for the NSID and DS groups was 9.28 (SD = 1.87) and 9.93 (SD = 2.30), respectively, with no difference between the groups, $t(30) = -0.882$, $p > .05$. The basic cognitive levels according to Raven's Standard Progressive Matrices (1986) for the NSID and DS groups were 11.61 (SD = 3.20) and 13.86 (SD = 3.68), respectively, with no difference between the groups, $t(30) = -1.845$, $p > .05$.

Assessment of participation in cognitively stimulating leisure activities

The Later Life Planning Inventory, which examines satisfaction of adults with ID from leisure and recreational activities, served as our baseline (Heller, Miller, Hsieh, & Stern, 2000; Lifshitz, 2002). We asked three participants with ID (one living in a community residence, one in an apartment and one with his parents) whether they currently engage in these activities, and to list additional leisure activities in which they engage. They added activities reflecting the spirit of the times, such as using technological devices and studying in academic courses.

The final version included two subscales (20 items): (a) the cognitive activity scale, including 10 more cognitively involving items, e.g., playing chess, checkers, or card games, reading, using laptops/tablets/iPads, participating in academic courses, drama, etc.; (b) the leisure activity scale, including 10 less cognitively involving items, e.g., listening to the radio, watching TV, PhotoShop, dancing, listening to music, doing sports, karaoke, cooking, pet care, etc..

The participants were asked whether and how often they engage in each activity. The answers were coded on a 5-point scale (Wilson et al., 2002): (5) every day; (1) once a month. The mean of participating in cognitive activities for participants with NSID and DS was 4.30 (SD = 0.51) and 4.00 (SD = 0.51), respectively, and in leisure activities 3.71 (SD = 0.68) and 3.88 (SD = .68), respectively, with no difference between the groups, t (30) = 1.65, $p > .05$ and t (30) = .98, $p > .05$, respectively. Three judges (one academic scholar, the first researcher who is an academic scholar who came from the field, and a person who is in charge of leisure activities in a population with ID) ranked the cognitive load of the different activities according to the following components: basic cognitive concepts (color, size, shape, comparison, classification); math concepts (quantity, number); orientation in time and space; and Bloom's cognitive taxonomy (remembering, comprehension, analysis, synthesis, evaluation). The need for measuring the activity's cognitive load stemmed from the fact that in Wilson et al.'s (2002) scale, most of the activities were of the cognitive type (reading, playing cards, etc.). The leisure activities of the participants included pursuits that are common among populations with ID, but are less cognitively demanding. Unlike the general population, these activities are used for improving the emotional condition of adults and elderly, but not for cognitive purposes. Thus, cognitively demanding pursuits (i.e., participating in academic courses, using technological devices) did not receive the appropriate weight on the scale. Therefore, we decided to insert a measure of the activities' cognitive load.

We used a 1−5 scale (1: 4 of the above cognitive components, 2: 8 components, 3: 12 components, 4: 16 components, and 5: 20 components). Pearson correlation matrixes between the three judges ranged between $r = .9$ and 1.00. The mean of the cognitive load for the new cognitive scale (hereafter cognitively stimulating activities) for participants with NSID and DS was 13.62 (SD = 1.17) and 10.42 (SD = 1.23), respectively, $t = .70$, $p > .05$, and for the new leisure scale (hereafter recreational load scale or recreational-stimulating activities), it was 10.22 (SD = 6.42) and 12.07 (SD = 1.84), respectively, $t = .78$, $p > .05$.

Cognitive test battery

Two tests were used to assess MA and basic cognitive level (independent variables). Ten tests were used to examine crystallized and fluid abilities (dependent variables).

Mental age: The Peabody Picture Vocabulary Scale (Dunn & Dunn, 1997) was administered according to the manual's instructions. Although it is a verbal test, it is correlated with general intelligence (Dunn & Dunn, 1997).

Basic cognitive level: The Standard Progressive Matrices (Raven, Court, & Raven, 1986) assesses the ability to form comparisons, deduce relationships, correlates, and reason by analogy. It refers to fluid intelligence (Raven et al., 1986), and is considered a measure of general intelligence (Spearman, 1927). Participants solved Sets AB, B (Raven colored matrices, RCM) C, D, and E. Correct answers received 1 point. Scores were the sum of the raw scores. *The crystallized battery* included: phonemic fluency, synonyms, idiom comprehension, and conventional verbal metaphor comprehension. They are of the crystallized type, are composed of declarative verbal acquired knowledge and are based on previous learning and acculturation (Ackerman & Rolfhus, 1999). A pretest among 10 participants conducted for all the tests found them suitable for individuals with ID.

*Phonemic Fluency Test (*Kave, Kukulansky-Segal, Avraham, Herzberg, & Landa, 2010) examines verbal knowledge, flexibility, and executive control functions. Participants provide as many words as possible beginning with each of three letters (/b/, /g/, /sh/) within 60 seconds. The score is the sum of the words generated for all three letters (test−retest reliability = .86).

Synonyms (Glanz, 1989) examines verbal abstract thinking or verbal intelligence abilities (12 items), and are highly correlated with the Verbal Wechsler intelligence tests. Participants were presented with a key word and were asked to find a similar word from a list of five other words (e.g., wall: gate, path, way, balcony, side). Correct answers received 1 point (range 0−12). Lifshitz, Klein, and Fridel (2010) used it in a population with ID (test−retest reliability = .90).

Conventional Verbal Metaphor (CVM) Test (Mashal & Kasirer, 2011) examines the understanding of conventional metaphors, based on prior knowledge and coded in the mental lexicon (e.g., 'sharp tongue'). Four interpretations were offered for each of the 10 metaphors: a correct metaphoric interpretation, a literal distracter, an unrelated interpretation, and a fourth choice: 'this expression is meaningless'. Correct answers received 1 point (range 0−10) (test−retest reliability = .85).

Idiom comprehension (Mashal & Kasirer, 2011) examines the understanding of figurative meanings of idioms (20 items, e.g., 'he got cold feet'). Four interpretations were offered: a correct idiomatic interpretation, a literal interpretation, a literal distracter, and an unrelated interpretation. Correct answers received 1 point (range 0−20) (test−retest reliability = .71).

The fluid battery included four tests: Trail Making Test (TMT), Homophone Meaning Generation Test (HMGT), Metaphoric Triad Test (MTT), and Novel Metaphors Test, which are of a fluid type and require the ability to deal with novelty. They are culturally unbiased nonverbal tests (Kaufman, 2001).

Homophone Meaning Generation Test (HMGT) (Mashal & Kasirer, 2011) examines the ability to shift between the different meanings of a homophone (10 items in Hebrew). The participants were instructed to say all meanings of the homophone, e.g., 'He wrote a letter'. Correct answers received 1 point (range 1−10) (test−retest reliability = .83).

Metaphoric Triad Test (MTT) (Kogan, Connor, Gross, & Fava, 1980) examines understanding of visual metaphors. Metaphors involve awareness of similarities and relations between different domains, and the integration of analogous elements into novel concepts, and are considered a fluid task (Keil, 1986). We used 20 cards, each with two pictures that formed three types of metaphoric relations: configurational, affective, and conceptual. Responses were scored on a 5-point scale: 0 = inability to find a metaphoric relation; 1 = literal interpretation; 2 = comparison between the pictures; 3 = analogy between pairs; and 4 = correct metaphoric explanation (i.e., closed shutters). Scores ranged from 0 to 80 (test−retest reliability = .81).

Novel Verbal Metaphor Test (Mashal & Kasirer, 2011) examines the understanding of novel metaphors (10 items) that are not coded in the mental lexicon and do not rely on prior knowledge (e.g., 'pure hand'). Four interpretations were offered (see conventional metaphors). Correct answers received 1 point (range 0−10) (test−retest reliability = .81).

Trail Making Test (TMT) (Reitan & Davison, 1974) examines executive function processes and is widely used in neuropsychology (Lezak, Howieson, & Loring, 2004). Part A measures visual scanning and tracking, motor speed, and focused attention. Participants are asked to draw lines to connect consecutive digits printed in scattered patterns on a page. Part B measures cognitive flexibility, set shifting, and divided attention, and requires drawing lines that connect sequences of letters and digits, alternatively (e.g., 1-A-2-B and so on). The total score is the time in seconds spent to complete the two tests.

Procedure

Consent for participation in the study was obtained from the participants' parents/guardians. Authorizations were obtained from the University Ethics Committee and the Division of Individuals with ID in the Ministry of Welfare. The study's aim and procedure were explained to all participants, who signed an adapted informed consent form for participation in scientific research. Participants chose payment or a gift for participating in the study.

The study was conducted in two stages. In the first two-hour stage (with 15 minutes refreshment between the two hours), the Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 1997), the Raven test (1986), and the Cognitive/Leisure Activity Questionnaire were administered individually to each participant by the second author in a small room in the participants' vocational and residential facilities.

The second two to three-hour stage was conducted one day later, in two parts. First, the Verbal Metaphoric Test was administrated, along with the idioms, Homophone Meaning Generation and Phonemic Fluency Tests. After a 45-minute break, the synonym, TMT, and the MTT (in a power point presentation) were administered.

Results

Due to our small sample size, Shapiro−Wilk analyses were performed for each of the dependent variables. The findings indicated that all dependent variables were normally distributed in both etiology groups ($p > .05$). Parametric analyses were, therefore, performed for each group separately.

Table 1. Crystallized and fluid scores according to groups (NSID, DS).

	DS group ($n = 14$)		NSID group ($n = 18$)			
t	SD	*M*	SD	*M*	Tests (range)	
−0.281	7.49	14.64	7.54	13.89	Phonemic fluency	Crystallized tests
0.305	2.02	3.93	1.37	4.11	Synonyms (0−12)	
−1.284	3.38	6.79	2.01	5.56	Idioms (0−20)	
1.461	1.10	1.86	1.15	2.44	Verbal CM (0−10)	
−0.327	2.38	11.57	2.63	11.28	HMGT	Fluid tests
−0.591	9.05	26.79	9.43	24.82	Visual MTT (0−80)	
−1.117	1.09	3.50	1.59	2.94	Verbal NM (0−10)	
0.721	87.05	160.43	87.70	182.89	TMT (minutes)	

Note: CM = conventional metaphors; HMGT = homophone meaning generation test; MTT = metaphoric triad test; NM = novel metaphors; and TMT = trail making test.

Crystallized and fluid tests

A *t*-test analysis for independent samples for each of the dependent variables was conducted in order to examine differences between the NSID and DS etiologies. No significant differences were found between the two etiologies in the crystallized and fluid tests (Table 1).

In order to examine whether differences in cognitive functioning would be found according to age groups, we divided the sample into two age cohorts: 25−40 ($n = 14$) and 40+ ($N = 18$) and performed a *t*-test for each of the crystallized and fluid tests. None of the tests yielded significant differences between the age groups (Table 2).

Pearson correlations between recreational and cognitively stimulating activities and the crystallized and fluid tests

Pearson correlations performed between the crystallized and fluid tests and the *recreational and cognitively stimulating activities* (the cognitive load of each type of activity) indicate that recreational-stimulating activities were positively correlated with one test only: a higher score in recreational activity was associated with higher scores in the phonemic fluency test and vice versa, $r(30) = .44$, $p < .05$. The cognitively stimulating activities yielded more correlations: higher scores in cognitively stimulating activities were associated with higher scores in phonemic fluency, idioms, and homophone meaning generation, $r(30) = .41−.47$, $p < .01$. The TMT was negatively correlated with cognitively stimulating activities, $r(30) = −.56$, $p < .01$: higher cognitively stimulating activities were associated with faster performance time.

Contribution of participants' background characteristics and cognitive/recreational scores to crystallized and fluid test performance

A series of multiple regression analyses were performed for each test, for the NSID and the DS groups separately, in order to examine the contribution of the independent variables (PPVT, Raven, CA, cognitive/recreational scores) to the crystallized tests. Results are presented in Table 3.

Participants with NSID

The regression model was significant for the Phonemic Fluency Test, $F(5,12) = 7.32$, $p < .005$. Thus, the five independent variables were found to account for 75.3% of the explained variance. PPVT ($p < .05$) and recreational-stimulating scores ($p < .05$) contributed significantly to the explained variance of this test. The regression for the other dependent variables was not significant: conventional metaphors, $F(5,12) = 1.34$, $p > .05$, idioms, $F(5,12) = 1.64$, $p > .05$, and synonyms, $F(5,12) = 0.93$, $p > .05$.

Table 2. Multiple regression for crystallized tests by PPVT, Raven, CA, cognitive, and recreational stimulating scores.

T	β	*SE B*	*B*	Predictor variable	
				phonemic fluency	
*2.62	44.	06.	17.	PPVT	NSID group
0.62-	12.-	46.	28.-	Raven	
0.02-	00.-	17.	00.-	CA	
*3.02	87.	17.	51.	Recreational stimulating	
0.97	27.	33.	32.	Cognitive stimulating	
				Synonyms	
1.29	37.	02.	03.	PPVT	
0.33	11.	14.	05.	Raven	
0.35-	12.-	05.	02.-	CA	
0.23	11.	05.	01.	Recreational stimulating	
0.82-	39.-	10.	08.-	Cognitive stimulating	
				Phonemic fluency	DS group
0.80	45.	21.	17.	PPVT	
0.59-	33.-	1.16	68.-	Raven	
0.39-	19.-	61.	24.-	CA	
0.81	51.	61.	50.	Recreational stimulating	
0.68	35.	56.	38.	Cognitive stimulating	
				Synonyms	
**4.45	1.42	03.	14.	PPVT	
0.84-	27.-	17.	15.-	Raven	
0.17	05.	09.	02.	CA	
1.36	48.	09.	13.	Recreational stimulating	
*2.98	86.	08.	25.	Cognitive stimulating	

Note: PPVT = Peabody Picture Vocabulary Test; CA = chronological age; SE = standard error.
*$p < .05$.
**$p < .005$.

Table 3. Multiple regression for fluid tests by PPVT, Raven, CA, cognition, and recreational stimulating (cognitive load) scores.

t	*β*	*SE B*	*B*	Predictor variable	
				HMGT	
***4.15	66.	02.	09.	PPVT	NSID group
1.30-	24.-	15.	20.-	Raven	
1.31	25.	06.	07.	CA	
0.21	06.	06.	01.	Recreational stimulating	
1.29	34.	11.	14.	Cognitive stimulating	
				Visual MTT	
**4.02	79.	09.	38.	PPVT	
1.13-	25.-	67.	75.-	Raven	
0.02-	01.-	25.	01.-	CA	
2.12	71.	25.	53.	Recreational stimulating	
*2.25	73.	47.	1.07	Cognitive stimulating	
				TMT	
*2.42-	52.-	96.	2.34-	PPVT	
0.82-	21.-	6.84	5.64-	Raven	
1.77-	46.-	2.56	4.52-	CA	
1.76	65.	2.54	4.48	Recreational stimulating	
*2.35-	84.-	4.87	11.46-	Cognitive stimulating	
				HMGT	
0.78	20.	03.	02.	PPVT	DS group
**4.45	1.15	17.	74.	Raven	
1.76	39.	09.	15.	CA	
2.25	64.	09.	20.	Recreational stimulating	
*3.29	77.	08.	26.	Cognitive stimulating	
				Visual MTT	
*2.71	85.	14.	38.	PPVT	
1.58	49.	77.	1.22	Raven	
0.20-	05.-	41.	08.-	CA	
1.51	52.	41	61.	Recreational stimulating	
*3.28	93.	37.	1.22	Cognitive stimulating	
				TMT	
*2.41-	84.-	1.50	3.63-	PPVT	
0.14-	05.-	8.28	1.16-	Raven	
0.18	05.	4.36	79.	CA	
1.35-	52.-	4.38	5.91-	Recreational stimulating	
0.68	22.	3.99	2.73	Cognitive stimulating	

Note: PPVT = Peabody Picture Vocabulary Test; CA = chronological age; TMT = trail making test; HMGT = homophone meaning generation test; MTT = metaphoric triad test..
*$p < .05$.
**$p < .005$.
***$p < .001$.

Participants with DS

The five independent variables accounted for 77.3% of the explained variance for the synonyms test, $F(5,8) = 5.46$, $p < .05$. PPVT ($p < .005$) and cognitively stimulating scores ($p < .05$) contributed significantly to the explained variance. The regressions for the other dependent variables were not significant.

A series of multiple regression analyses were performed for each test, for the NSID and the DS groups separately, in order to examine the contribution of the independent variables to the fluid tests. Results are presented in Table 4.

Table 4. Correct responses (SD) in idioms, conventional metaphors (CM), and novel metaphors (NM) tests according to median cognitively stimulating scores (low/high).

	High cognition		Low cognition			
t	SD	*M*	SD	*M*		
0.94	1.77	6.63	1.83	4.70	Idioms	NSID group
2.60*	0.83	3.12	1.10	1.90	Verbal CM	
−0.13	2.00	3.00	1.29	2.90	Verbal NM	
−2.25*	3.60	8.83	2.37	5.25	Idioms	DS group
−0.91	0.75	2.17	1.30	1.63	Verbal CM	
−2.27*	0.75	4.17	1.07	3.00	Verbal NM	

*$p < .05$

Participants with NSID

The five independent variables accounted for 66.7% of the explained variance of the MTT, $F(5,12) = 4.81$, $p < .05$. The PPVT ($p < .005$) and cognitively stimulating scores ($p < .05$) contributed significantly to the explained variance. The five independent variables accounted for 59.6% of the TMT, $F(5,12) = 3.53$, $p < .05$. The PPVT ($p < .05$) and cognitively stimulating scores ($p < .05$) contributed significantly to the explained variance. The five independent variables accounted for 78% of the explained variance of the HMGT, $F(5,12) = 8.51$, $p < .001$, but only PPVT ($p < .001$) contributed significantly to the explained variance of this test. The regression for the novel metaphor was not significant.

Participants with DS

The five independent variables accounted for 78.2% of the MTT, $F(5,8) = 5.75$, $p < .05$. The PPVT ($p < .05$) and cognitively stimulating scores ($p < .05$) were the variables that contributed significantly to the explained variance. The five independent variables accounted for 85.2% of the HMGT, $F(5,8) = 9.22$, $p < .005$. In this test, the Raven ($p < .005$) and cognitively stimulating activity ($p < .05$) contributed significantly to the explained variance. The five independent variables accounted for 72.9% of the TMT, $F(5,8) = 4.30$, $p < .05$. Only PPVT ($p < .05$) contributed significantly to the explained variance. The regression was not significant for the novel metaphor.

Differences in cognitive functioning according to median scores of the cognitive/recreational activities

The above Pearson correlations indicate a positive correlation between scores in cognitively stimulating activities and idioms, $r(30) = .47$, $p < .01$. However, there were no significant correlations between cognitively stimulating and recreational-stimulating scores and the conventional and novel metaphors. We divided the participants into two groups according to their median scores in recreational-stimulating activities (13 and 9 for participants with NSID and SD, respectively) and cognitively stimulating activities (11 and 13 for participants with NSID and DS, respectively) in order to more thoroughly examine the effect of participation in recreational and cognitively stimulating activities on idioms, conventional, and novel metaphors tests. The scores of idioms, conventional, and novel metaphors in the two groups according to the median scores in recreational and cognitively stimulating scores are presented in Table 4.

Table 4 yielded significant differences in the conventional metaphors test according to the median cognitive stimulating score. Participants with higher scores in cognitively stimulating activities exhibited significantly higher scores in idioms (NSID group), conventional, and novel metaphors (DS group) than participants who participated less in cognitively stimulating activities. There were no differences among the three tests according to the median recreational-stimulating score.

Discussion

Three main issues are at the core of the discussion: (a) the association between participation of adults with ID with/without DS in recreational and cognitively stimulating activities and their functioning in crystallized and fluid tests; (b) the differential effect between the NSID and DS groups; and (c) the implications of our findings for adulthood and aging in populations with ID.

Association between participating in recreational and cognitively stimulating activities and the crystallized and fluid tests

As hypothesized, participation in recreational and cognitively stimulating activities influenced the crystallized and fluid functioning of adults with ID. This suggests that adults with ID with and without DS can benefit not only from compensation-focused interventions (Lifshitz and her colleagues), but that non-targeting cognitive stimulation conveyed during leisure activities may also contribute to their functioning in cognitive tests. One might argue that our sample is small. However, the regression analysis indicated that the five independent variables account for 59.6%−85.2% of the explained variance of the independent variables, indicating higher association between cognitive stimulating activities and cognitive functioning. Despite its small sample size, the contribution of our study lies in the fact that this is the first attempt to find an association between participating in leisure activities of populations with ID and their cognitive functioning.

The findings indicate that recreational-stimulating activities were associated with phonemic fluency. This is in accordance with studies in the general population (Kim & Kim, 2014), in which recreational-stimulating activities promoted language skills among healthy elderly persons (Mahncke et al., 2006) and among patients with dementia (Spector, Orrell, & Woods, 2010). However, more cognitively demanding activities have accumulated side effects that contributed to most of the crystallized and fluid tests (three out of four in each type for the NSID and DS groups).

In line with the Cognitive Activity Theory (Wilson, Barnes, & Bennett, 2007) and the CAT (Lifshitz-Vahav, 2015), our findings show that life style contribute to the cognitive functioning of adults with and without DS, even at an advanced age. Due to the special needs of the population with ID, we used a second measure, in addition to the scale suggested by Wilson and Bennett (2003), to examine the effect of participation in leisure activities on cognitive functioning. Our findings suggest that the frequency and cognitive load of the leisure activities contributed to the crystallized and fluid functioning of our participants.

The hypothesis about different patterns of influence between recreational and cognitively stimulating activities was also supported. The marginal effect of recreational-stimulating activities on phonological fluency can be attributed to: (a) lack of knowledge about the application of the ideas of reserve and growth in old age to the field of ID; (b) the nature of learning in populations with ID.

Concepts of reserve and compensation which are inherent in the Cognitive Reserve Theory (Stern et al., 2005), Cognitive Activity Theory (Wilson et al., 2007), and CAT (Lifshitz-Vahav, 2015) are still in their infancy regarding adults with ID.

Leisure activities in populations with ID are used as a means for improving satisfaction and well-being (Bergström, Hochwälder, Kottorp, & Elinder, 2013), quality of life (Patterson and Pegg, 2009), or self-concept (Duvdevany & Arar, 2004; Faisal, Croitoru, Rimmerman, & Naon, 2011). The idea of using these activities to introduce cognitive concepts has not been envisioned until now.

Individuals with ID have difficulty benefiting from direct learning exposure − unmediated encounters with stimuli in the environment − as opposed to direct learning experiences (Feuerstein & Rand, 1974; Tzuriel, 2013). Mediated learning occurs when the environment is interpreted for an individual by a mediator who actively structures meaningful components of that environment, as well as of past and future experiences.

Healthy, typically developing adults benefit from direct learning exposure. When engaging in leisure activities, they not only enjoy themselves and acquire skills, but relate to cognitive concepts contained in the activities (Kim & Kim, 2014). When adults with ID engage in leisure activities, they concentrate only on emotional and behavioral components. The uniqueness of our study is its assessment of the impact of cognitively stimulating leisure activities on the performance of adults with ID in crystallized and fluid tests.

Lifshitz et al. (2010) used the MISC (Mediational Intervention for Sensitizing Caregivers) as a tool for enhancing the cognitive, autonomous, and behavioral functioning of adults and the elderly with ID through daily activities, domestic, and vocational tasks. The results suggest that routine daily activities could serve as a means for enhancing literacy and cognitive concepts.

Action should, therefore, be taken to introduce policy-makers, administrators, and care-giving personnel to the ideas of compensation and growth in adulthood. Staff should be guided to encourage adults with ID to participate in leisure activities more frequently, and also to use them as a means for enhancing the cognitive literacy of adults with ID, in addition to the contribution these activities make to their emotional and behavioral functioning. Our research outcomes suggest that leisure activities can serve as a cost-effective and relatively easy tool for use in rehabilitation centers of adults with ID.

The influence of participating in recreational and cognitively stimulating activities among participants with NSID and DS

The NSID and DS groups in our study were matched in CA, MA, and basic cognitive level. They exhibited similar crystallized and fluid test performance. There were only marginal differences in the contribution of participation in cognitive and recreational activities on the cognitive functioning of the two etiologies.

In the crystallized tests, participation in recreational-stimulating activities (i.e., cooking, dancing) was associated with phonological fluency in the NSID but not in the DS etiology. This finding is not surprising, given the fact that individuals with DS exhibit deficits in linguistic skills (Chapman, 2006). It has been documented that their level of understanding and their semantic ability exceed their phonological ability (Chapman, 2006). It is also not surprising that in the DS etiology, participating in cognitively stimulating activities was associated with synonyms and idioms. As for the fluid battery, participation in cognitively stimulating activities was associated with the TMT, an executive function test, in the NSID group, and with the homophone test in the DS group. The latter test requires the production of alternative meanings for a given word which demands creative ability (Kasirer & Mashal, 2014). Our findings also indicate that participation in cognitively stimulating activities was associated with conventional verbal metaphors in the NSID group and with novel metaphors in the DS group. This finding correlates with the original study (Shnitzer, 2015), where the score of the conventional metaphors of the NSID group was significantly higher than that of the DS group. The opposite was true for novel metaphors.

Implications for adulthood and aging in populations with ID

Our study was conducted among adults with ID aged 25−55. Several studies found a cognitive decline with increasing age among adults with ID with and without DS (Janicki & Dalton, 2000; Zigman et al., 2004). Despite the broad age range of our participants, CA was not associated with their cognitive functioning in any of the crystallized and fluid tests in the two etiologies. A *t*-test performed for each of the cognitive batteries did not yield a decline in the older age group. Our findings refute previous findings which claim a cognitive decline with increasing age among adults with ID. The findings empower the CAT (Lifshitz-Vahav, 2015), indicating stability of cognitive functioning among adults with ID even at an advanced age, such as 50 and above (Devenny et al., 1996; Head et al., 2007; Lifshitz & Klein, 2011; Lifshitz & Tzuriel, 2004).

The CAT (Lifshitz-Vahav, 2015) was supported in that the cognitive functioning of adults with ID is not dependent solely on endogenous factors such as CA or etiology, but also on the contribution of exogenous factors such as life style. Our findings indicate that the Cognitive Activity Theory can be applied in populations with ID in the immediate time frame (Wilson et al., 2005). That is, frequent participation in cognitively stimulating activities influences cognitive performance of adults with ID with and without DS. We anticipate that recurrent participation of adults with ID in cognitively stimulating activities during adulthood may have a long-term effect, and may serve as a protective factor against their accelerated deterioration.

Limitations and future research

Generalization should be regarded with caution due to the small sample size. Future research, using a broader sample, would help validate the findings for populations with ID.

One could argue that there might be a reciprocal relationship between MA and the type of cognitive activities in which adults with ID engage. That is, the higher the MA or intelligence level of the participants, the more they participate in leisure activities with greater cognitive load. This claim, which was not examined in the general population, might be true for populations with ID. However, the bilateral relations between participation in cognitive activities and cognitive functioning should be examined at two time points.

Our study supports the short-term implications of applying the Cognitive Activity Theory to a population with ID. A longitudinal study should be conducted in order to support the theory's claim about reducing the risk of Alzheimer's disease among adults with ID.

Since this study was part of a larger one, the association between participation in cognitively stimulation activities and cognitive functioning was limited to the crystallized and fluid tests that were used in the original study. Examining the effect of participating in cognitively stimulating activities on intelligence, working, and long-term memory is recommended.

Our study is the first to address the applicability of the Cognitive Activity Theory among adults with ID. The life expectancy of adults with Autism has also increased. Examining the implications of the Cognitive Activity Theory in the autism spectrum disorder population is recommended.

Disclosure statement

The authors confirm that there are no conflicts of interests of any type for all three authors.

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