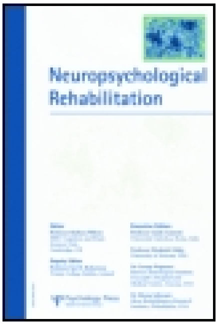

Neuropsychological Rehabilitation: An International Journal

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/pnrh20

Behavioural Assessment of the Dysexecutive Syndrome for Children (BADS-C): An examination of construct validity

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Version of record first published: 02 Sep 2009.

NEUROPSYCHOLOGICAL REHABILITATION
2009, 19 (5), 662–676

Psychology Press
Taylor & Francis Group

Behavioural Assessment of the Dysexecutive Syndrome for Children (BADS-C): An examination of construct validity

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Children's success with participating in life depends heavily on intact executive function (EF) skills. The Behavioural Assessment of the Dysexecutive Syndrome for Children (BADS-C) was developed to address the need for a standardised ecologically valid test of children's EF performance. This study aimed to establish the construct validity of the BADS-C in relation to socio-demographic parameters. Participants were 208 Israeli children, aged 8–15 years, who were divided into three age groups (8 years to 9 years and 11 months; 10 years to 11 years and 11 months; 12 to 15 years) and tested with the BADS-C. The older age groups achieved significantly better scores than the younger groups. No significant differences were found between genders in any of the BADS-C scores. Similar results were found for familial socio-economic status and parents' education. Construct validity was demonstrated for the BADS-C by providing a profile for different age groups. Additional studies are needed to examine further the validity and reliability of the BADS-C and the relationships between socio-demographic factors and EF.

Keywords: Executive function; Children; BADS-C; Validity.

INTRODUCTION

Children's success with participating in various domains of life, such as learning, social interactions, leisure activities, and activities of daily living

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http://www.psypress.com/neurorehab DOI:10.1080/09602010802622730

(ADL), depends heavily on effective executive function (EF) skills (Ylvisaker & Feeney, 2002). Welsh and Pennington (1988) defined executive functions as the ability to adopt and maintain an appropriate problem-solving set to obtain a future goal. In fact, executive function is an umbrella term that includes high-level cognitive functions, such as setting and managing goals, planning, inhibition and dealing with diverse elements, shifting between cognitive and affective sets, organisation, working memory, and meta-cognition (Ylvisaker & Feeney, 2002). Executive functions are also heavily involved in socioemotional behaviours, control over emotions and regulating emotional responses to others (Vohs et al., 2008; Wåhlstedt, Thorell, & Bohlin, 2008).

Executive functions begin to develop and appear soon after birth in a slow progression to full adult development (Dawson & Guare, 2004). Although individual variations occur in the EF developmental process (Espy & Kaufman, 2002), there has been a lack of research regarding the developmental differences in EF skills among children (Hughes, 2002; Welsh, 2002).

Due to the complexity of this domain, the assessment of EF mechanisms is challenging and requires finding the appropriate performance-based measure to evaluate functional real-world impact on EF, as expressed in everyday activities (Isquith, Crawford, Espy, & Gioia, 2005). The ecological validity of measuring EF refers to the conditions under which generalisations can be made from controlled experiments to natural real-life scenarios (Norris & Tate, 2000; Tupper & Cicerone, 1990).

Some investigators have combined neuropsychological tests for EF with a "real-life" task (e.g., Lawrence et al., 2004) or have developed tasks in the experimental laboratory that hold promise of appropriate reliability and validity for the clinical laboratory (e.g., Isquith et al., 2005). Other investigators have used parent/teacher questionnaires, such as the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000), or self-report questionnaires (e.g., Duckworth & Seligman, 2006). Although the use of such questionnaires may contribute to our knowledge about EF among children, as well as to the clinical intervention process, there are researchers who claim that they are not an alternative for performance-based assessment and should be viewed instead as complementary (Isquith et al., 2005).

In order to address the need for a standardised ecologically valid test of EF performance among children, the Behavioural Assessment of the Dysexecutive Syndrome for Children (BADS-C; Emslie, Wilson, Burden, Nimmo-Smith, & Wilson, 2003) was developed. Baddeley and Wilson (1988) defined the dysexecutive syndrome as the cluster of deficits including attention, planning, problem solving and behavioural control. The BADS-C is an adaptation of the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996) designed for adults. The test includes two parts: a performance-based test and a 20-item questionnaire for caregivers (Dysexecutive Questionnaire for Children, DEX–C). This performance-based battery consists of six subtests – Playing Card, Water, Key Search, Zoo Map (1 and 2), and Six-part tests, which together evaluate the construct of EF as a whole.

Despite the strength of the ecological validity of the BADS-C, studies on its reliability and validity are not found in the literature, and studies using the battery are sparse (e.g., Hooper, Williams, Wall, & Chua, 2007). Thus, there is still a lack of performance-based ecologically valid "real-life" (Lawrence et al., 2004) tools with which to evaluate EF as a whole construct among children. The focus of the present study is on the construct validity of the BADS-C – an aspect that is not well established.

The BADS-C authors made efforts to ensure that their sample was representative of the population as a whole. However, children's age range was not reported in the manual. Concurrent validity was established by comparing the control group's scores on the six BADS-C subtests and their total scores, as well as their total scores on the DEX-C questionnaire, to Goodman's Strengths and Difficulties Questionnaire (SDQ; Goodman, 1999). Normative data and percentiles for children aged 8–15 years, 11 months are presented in the manual for the six BADS-C subtests, as well as for the total score (Emslie et al., 2003). The scores are adjusted and presented for children's age group and estimated IQ.

The present study aimed to establish the construct validity of the BADS-C among Israeli children aged 8–15 years. Construct validity refers to the capacity of an instrument to measure the intended underlying construct (Benson & Schell, 1997). The "known group method" is one of the most common approaches used to demonstrate construct validity. It involves identifying subjects who differ on the characteristics that the instrument is designed to measure (Kielhofner, 2006). The construct validity of most widely used tasks for evaluating EF has not been well established empirically (Welsh, 2002). Moreover, in those studies that have done so, the focus was on comparing a typical group of children to those with various psychopathologies (Schwartz, 2006), mainly attention deficit hyperactivity disorder (e.g., Bental & Tirosh, 2007).

Furthermore, although it is recognised that individual socio-demographic parameters, such as gender (e.g., Ardila, Rosselli, Matute, & Guajardo, 2005; Boghi et al., 2006), familial socio-economic status (e.g., Buckner, Mezzacappa, & Beardslee, 2003; Howse, Lange, Farran, & Boyles, 2003), and parents' education (e.g., Ardila et al., 2005) may impact on EF abilities, there is a lack of studies focusing on those individual differences among typical children (Espy & Kaufmann, 2002). Such studies were also not reported in the BADS-C manual. The present study aims to close this gap by conducting an analysis of differences between socio-demographic variables among typical children, such as age, gender, familial socio-economic status, and parents' education level.

METHOD

Participants

Participants were 208 children, aged 8–15 years (mean = 10.30; *SD* = 1.56), who were students at mainstream public schools located in the north of Israel. These schools draw children from a wide range of backgrounds.

The children were divided into three age groups: 8 years to 9 years and 11 months (Group 1); 10 years to 11 years and 11 months (Group 2); 12 to 15 years (Group 3). This division was performed based on previous reports, as for example, Brocki and Bohlin (2004) who mentioned three active stages of maturation in regard to the EF of children aged 6–13 years: early childhood (6–8 years of age); middle childhood (9–12 years of age); and early adolescence, similarly to Epstein's description of brain growth and mental growth (Epstein, 1978).

As presented in Table 1, participants' familial socio-economic level ranged from low to high, according to parents' report about their mean income level per month. The level of income as low, average or high was determined according to the values published by the Central Bureau for Statistics Israel (2006). The children's parents' education level ranged from non-academic (up to high school, meaning up to 12 years of education) to academic (university education, meaning 15 years of education and above).

Children with a known low IQ level of performance or neurological, developmental, or learning disabilities were excluded from the study.

Instruments

All subjects were tested with the BADS-C (Emslie et al., 2003), which is a standardised assessment battery that examines executive function in children and adolescents aged 8–16 years. The BADS-C consists of six subtests (adapted and simplified from the BADS) that assess inflexibility, perseverance, novel problem solving, impulsivity, planning, and the ability to utilise feedback in order to moderate behaviour. These tasks are similar to those required of children and adolescents in everyday life and are novel relatively to many other tests in wider use (Baron, 2007).

The BADS-C scoring sheet allows the clinician to record all responses and calculate raw test scores. The manual provides comprehensive norms (age-scaled scores and percentile ranks), based on a representative sample of

TABLE 1
Participants' demographic data

		General Sample		*Age group 8–9 yrs & 11 months*		*Age group 10–11 yrs & 11 months*		*Age group 12–15 yrs*	
		(n = 208)	*%*	*(n = 80)*	*%*	*(n = 89)*	*%*	*(n = 39)*	*%*
Residence	City	54	26	30	37.5	13	14.6	11	28.2
	Village	127	61	35	43.8	66	74.2	26	66.7
	Missing	27	13	15	18.7	10	11.2	2	5.1
Gender	Male	113	54.3	41	51.2	48	53.9	24	61.5
	Female	95	45.7	39	48.8	41	46.1	15	38.5
Father's education	Academic	87	41.9	42	52.5	29	32.6	16	41
	Non-academic	81	38.9	37	46.3	27	30.3	17	43.6
	Missing	40	19.2	1	1.2	33	37.1	6	15.4
Mother's education	Academic	119	57.2	42	52.5	53	59.6	24	61.5
	Non-academic	84	40.4	38	47.5	31	34.8	15	38.5
	Missing	5	2.4			5	5.6		
Familial socio-economic status	Low	30	14.5	17	21.2	7	7.9	6	15.4
	Middle	124	59.6	46	57.5	51	57.3	27	69.2
	High	51	24.5	17	21.3	28	31.5	6	15.4
	Missing	3	1.4			3	3.3		

259 children balanced for gender, mean estimated IQ, and socio-economic background. Norms are provided for eight age groups and three IQ groups.

Raw scores for each of the component subtests can be converted to age-scaled scores, which are adjusted for the child's age and estimated IQ. Age-scaled scores range from 1 to 19 and are designed to be approximately normally distributed, with a mean of 10 and a standard deviation of 3. The range of the total age-scaled scores of all subtests is 35–85. The total age-scaled score is converted to an "overall scaled score", ranging from 49 to 146.

According to the overall scaled score, the results are classified functionally as follows: Impaired performance (overall scaled score range 49–68); borderline performance (overall scaled score range 70–78); low average performance (overall scaled score range 80–88); average performance (overall scaled score range 90–109); high average performance (overall scaled score range 111–119); and superior performance (overall scaled score range 121–146).

In addition to the child's scores on the BADS-C, test interpretation involves the clinician's detailed observations on test performance. Moreover, the score from the 20-item DEX-C questionnaire is also considered. The DEX-C allows parents and teachers to rate the child on a range of emotional/personality, motivational, behavioural, and cognitive problems usually associated with the dysexecutive syndrome. Such qualitative information helps the clinician to understand the relationship between the child's test performance and the everyday problems experienced by the child at home or in school.

In the present study, the construct validity of the BADS-C will be examined in relation to socio-demographic parameters, including age, gender, familial socio-economic status, and parents' education.

Familial socioeconomic status was divided into three categories: (1) low, (2) middle, and (3) high. Parents' education was divided into two levels: (1) non-academic and (2) academic.

Procedure

The study was approved by the Institutional Review Board of the University of Haifa. All parents signed a consent form allowing their children to participate in this study.

Translation of the instrument to Hebrew, with back translation into English, was performed by a bilingual clinician. The BADS-C was administered by the researchers to each child individually in his or her school. Data collection lasted for about 40 minutes for each child.

Data analysis

Descriptive statistics revealed an abnormal distribution of BADS-C raw scores. Thus, a non-parametric Kruskal-Wallis test (K-W χ^2) was conducted to determine whether BADS-C scores varied as a function of age group and parents' education level. A Mann-Whitney *U* test was used to calculate the significance of the differences between genders and between children from different socio-economic groups. Probabilities below .05 were considered significant.

RESULTS

Age group

A comparison of BADS-C raw scores revealed that significant differences exist between the different age groups, as presented in Table 2.

Results of the Mann Whitney *U* test on the BADS-C raw scores revealed that the two older age groups achieved significantly higher scores than the youngest group in most of the subtests (see Table 3).

The present study also examined BADS-C scores in relation to gender, familial socio-economic status, and parents' education level. No significant

TABLE 2
Means, standard deviations of BADS-C raw scores and significance of differences between the age groups

	Age Group 1 (n = 80)		*Age Group 2 (n = 89)*		*Age Group 3 (n = 39)*			
BADS-C raw scores	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*K-W* χ^2	*p*
Playing Card Test*	2.35	2.78	1.31	1.62	0.75	0.95	16.1	<.0001
Water Test	7.26	2.39	7.78	2.45	8.75	2.19	13.38	.001
Key Search Test	5.83	4.36	8.51	4.33	9.86	3.92	19.6	<.0001
Zoo Map Test 1	2.92	2.46	4.83	2.89	4.94	3.03	26.9	<.0001
Zoo Map Test 2	6.77	2.49	7.05	1.35	7.45	0.73	3.38	*ns*
Six-part Test	10.73	3.62	11.2	3.67	11.4	3.53	1.73	*ns*

ns = not significant

* In this test, a higher score represents a higher number of errors. Thus, the younger participants made more errors than did the older participants.

TABLE 3
The significance of differences between the age groups in five of BADS-C subtests

	Age Group 2 scored better than Age Group 1		*Age Group 3 scored better than Age Group 2*		*Age Group 3 scored better than Age Group 1*	
BADS-C raw scores	*Mann Whitney*	*p*	*Mann Whitney*	*p*	*Mann Whitney*	*p*
The Water Test	3036.5	*ns*	1292	.016	936	<.0001
Key Search Test	2526.5	.001	1409	*ns*	858.5	<.0001
Zoo Map Test 1	1956.5	<.0001	1660	*ns*	943.5	<.0001
Zoo Map Test 2	3104	*ns*	1482	*ns*	1558	*ns*
Six Part Test	3267.5	*ns*	1639	*ns*	1343.5	*ns*

ns = not significant

TABLE 4
BADS-C raw scores means and standard deviations of both genders

	Boys (n = 113)		*Girls (n = 95)*	
BADS-C raw scores	*Mean*	*SD*	*Mean*	*SD*
Playing Card Test	1.63	2.28	1.36	1.95
Water Test	7.84	2.44	7.79	2.26
Key Search Test	7.41	4.54	8.47	4.69
Zoo Map Test 1	3.61	3.35	3.62	3.47
Zoo Map Test 2	7.01	2.05	7.14	1.2
Six-part Test	10.97	3.61	11.19	3.44

ns = not significant

TABLE 5
Means and standard deviations of BADS-C scores according to participants' familial socio-economic status

	Low socio-economic level (n = 30)		*Middle socio-economic level (n = 124)*		*High socio-economic level (n = 51)*	
BADS-C raw scores	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Playing Card Test	1.73	2.57	1.45	1.98	1.56	2.3
Water Test	7.56	2.7	8.04	2.09	7.37	2.71
Key Search Test	6.5	4.51	7.99	4.57	8.21	4.58
Zoo Map Test 1	3.36	3.39	3.84	3.38	3.35	3.25
Zoo Map Test 2	6.96	1.32	7.11	1.78	7.05	1.79
Six-part Test	10.83	2.85	11.35	3.58	10.58	3.77

TABLE 6
Means and standard deviations of BADS-C scores according to parents' education levels

	Father's education level				*Mother's education level*			
	Non-academic (n = 81)		*Academic (n = 87)*		*Non-academic (n = 84)*		*Academic (n = 119)*	
BADS-C raw scores	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Playing Card Test	1.48	2.23	1.74	2.21	1.75	2.15	1.37	2.15
Water Test	7.8	2.51	8.09	2.01	7.53	2.54	7.94	2.22
Key Search Test	7.71	4.89	8.51	4.41	7.57	4.84	8.05	4.39
Zoo Map Test 1	3.32	3.52	3.5	3.37	3.78	3.35	3.53	3.35
Zoo Map Test 2	7.24	1.15	6.94	2.32	7.11	1.78	7.03	1.71
Six-part Test	11.38	3.18	11.42	3.56	11.15	3.38	11.01	3.67

differences were found between genders in any of the BADS-C subtests. Table 4 depicts the means and standard deviations of both genders.

Similar results were found for socio-economic status and parents' education. Tables 5 and 6 present the means and standard deviations of BADS-C scores according to participants' familial socio-economic status and parents' education levels.

DISCUSSION

The present study aimed to establish construct validity for the Behavioural Assessment of Dysexecutive Syndrome for Children (BADS-C) among

Israeli children aged 8–15 years, since executive functions are very important components that influence everyday life. We focused on the 8–15 age group, when EF development is accelerated and needed for successful participation in environments such as school (Howse et al., 2003) and in tasks of daily living.

Relationship between EF and age-related development

While the oldest age group (12–15 years) achieved significantly higher scores than the youngest age group (8–9 years and 11 months) in most BADS-C subtests, almost no significant differences were found between the 10–11 years and 11 months and 12–15 age groups. This may represent a stage of neural development at around 10–12 years of age as children cross the threshold between childhood and adolescence. This significant finding, present across BADS-C subtests, links with other previous reports and supports the growing body of research indicating differential trends in EF development (e.g., Gathercole, Pickering, Ambridge, & Wearing, 2004; Huizinga, Dolan, & van der Molen, 2006; Luciana, Conklin, Hooper, & Yarger, 2005) and age-dependent changes in children's EF performance. Brocki and Bohlin (2004) suggested three active stages of maturation in regard to the EF of children aged 6 to 13 years: early childhood (6–8 years of age), middle childhood (9–12 years of age), and early adolescence. In several publications, Epstein (1978) proposed that the brain does not grow linearly but in spurts during the first 18 years of life, with peaks that occur at 3–10 months and 2–4, 6–8, 10–12 or 13, and 14–16 or 17 years of age.

This finding is significant for other functions that involve EF, in typical development as well as in populations with disabilities. For example, Singer and Bashir (1999) claimed that the inter-relationship between language, executive functions and self-management of behaviour may underlie the social impairments associated with communication disorders. Turkstra, McDonald, and DePompei (2001) found that children with traumatic brain injury (TBI) scored lower in emotion recognition and conversation skills in comparison to controls. The authors emphasised that after TBI many of these skills do not continue to develop and social interactions are compromised. This is of most importance when considering therapy outcomes.

In the present study, the most sensitive subtests for successfully differentiating between the age groups were the Water Test, the Key Search Test, and the Zoo Map Test 1. The Water Test requires the development of a plan of action in order to solve a problem using the physical manipulation of a variety of materials. The Key Search Test examines the ability to plan an efficient, systematic, double plan of action, to monitor one's own performance, and to take into account factors that are not explicitly stated (Emslie et al., 2003). The Zoo Map Test 1 is a demanding open-ended task with little structure whereby the planning abilities of the child are rigorously tested (Emslie et al., 2003). These tests focus mainly on abstract thinking abilities – problem solving, sequencing, planning, and controlling impulsivity – and on more complicated and combined EF. Hence, age-related development will more likely be emphasised. Similarly, it has been suggested that the development of basic inhibitory functions precedes the development of more complex functions of selective attention, and that executive functions continue to develop into adolescence (Klenberg, Korkman, & Lahti-Nuuttila, 2001).

Relationship between EF and additional socio-demographic parameters

The present study also examined the contribution of socio-demographic parameters, such as gender, familial socio-economic status, and parents' education level to children's performance on the BADS-C.

No significant differences between genders were found in the participants' BADS-C scores. There are mixed results in the literature in this regard, with some studies reporting differences between genders in specific EF abilities (Ardila et al., 2005; Boghi et al., 2006; Brocki & Bohlin, 2004), while other reports show no difference between genders (Herba, Tranah, Rubia, & Yule, 2006).

No significant differences were found between the BADS-C scores of children from different socio-economic levels. Although the literature regarding the impact of socio-economic status on neuropsychological functions is sparse (Waber, Gerber, Turcios, Wagner, & Forbes, 2006), most reports show that children from high socio-economic backgrounds perform better on EF tests than children from lower socio-economic backgrounds (e.g., Buckner et al., 2003; Howse et al., 2003; Waber et al., 2006). Waber et al. (2006) provide a number of reasons for these differences in executive function, such as inequalities in the availability of resources (e.g., books and materials, class size), family and environmental factors, teacher preparation and training, and low expectations by faculty of poor and minority children. The present study highlights the advantage of the BADS-C in terms of its ability to reflect a child's executive function level in a direct manner that is not influenced by familial socio-economic status. In the present study, the general socio-economic level was determined according to parents' average income per month. About one third of the children were Arabic; most of them came from average socio-economic level. Inequalities in the availability of resources, teacher preparation and training and other environmental factors were not examined. It may be that the impact of these factors on children's cognitive and meta-cognitive performance will be tested in further studies. Another important aspect to be mentioned in regard to the use of BADS-C among children from lower socio-economic levels is that the simplified language and use of pictures in the BADS-C enable children with lower verbal abilities, for example, due to socio-economic or environmental deprivation to perform optimally, and overcome language gaps.

Parents' education level has also been related to children's general cognitive development (Ganzach, 2000). For example, Ardila et al. (2005) found that most children's test scores, particularly verbal test scores, were significantly correlated with parents' education level. Other studies claim that children of parents with higher education tend to have better language abilities (Hoff, 2003a, 2003b; Hoff-Ginsberg, 1991; Hoff, Laursen, & Tardif, 2002). On the contrary, the present study found no significant differences in the BADS-C scores of children according to their parents' education level. However, the relationship between parents' education level and children's EF abilities should be further examined by using ecologically valid assessments.

The differences between the present study results and those of previous studies regarding the relationship between EF and socio-demographic parameters may be due to differences in the characteristics of the assessments used. The BADS-C is a performance test with ecological validity while other tests evaluate separate EF components. This suggestion is supported by the claim of Gioia and Isquith (2004) that laboratory tests may not be sufficiently sensitive to variations in executive functions because the examiner provides external executive control for the child.

In summary, this study demonstrates the construct validity of the BADS-C among mainstream Israeli children. The BADS-C was found to express general sensitivity to age-related development and the ability to provide norms for different ages. Thus, the BADS-C may serve as an appropriate tool for evaluating EF in children and youths by also referring to their developmental status. This knowledge about children with typical development may serve as a platform for evaluating EF in children with learning disabilities or brain injury, and thus provide a better understanding of the relationship between a specific disability and impaired EF, and lead to optimal management (Baron, 2007).

These assessments should also refer to socio-demographic parameters. Although socio-demographic factors did not play a role in the scores of the participants in this study, there is a need to refer to environmental factors and contexts when evaluating children in research and in practice. This perspective is in accordance with the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001) model, which emphasises the need to refer to meaningful environmental factors that either hinder or facilitate children's participation (Law, 2002). Furthermore, this perspective may provide insight into the contribution of environmental disadvantages and the ways in which to promote children's optimal functioning and participation at school and in daily living. Such an understanding will allow therapists to better meet children's needs, maximise their involvement in treatment, and improve treatment efficacy.

This study has some limitations that should be considered in the interpretation of the results. First, we used a convenient sample without exactly matching the children according to age, gender, and socio-economic status. Furthermore, some of the measures were generalised and not divided into several sub-levels (e.g., parents' education level had only two sub-divisions: academic and non-academic). Therefore, the sample may not adequately represent the general population. Additional studies on more representative samples, which include, for example, larger percentages of children from difference socio-economic level or from different minorities, with more detailed sub-divisions of socio-demographic parameters, should be conducted in order to examine further the validity and reliability of the BADS-C and to shed light on the relationship between socio-demographic factors and EF among normal children, as well as among children with disabilities.

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Manuscript received April 2008
Revised manuscript received November 2008
First published online January 2009