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Adaptation of the Behavioral Assessment and Research System (BARS) for evaluating neurobehavioral performance in Filipino children

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Abstract

Neurobehavioral tests have long been used to assess health effects in exposed working adult populations. The heightened concern over the potential impact of environmental exposures on neurological functioning in children has led to the development of test batteries for use with children. There is a need for reliable, easy-to-administer batteries to assess neurotoxic exposure in children. One such test battery previously validated with Spanish- and English-speaking children ages 4 and older, combines computerized tests from the Behavioral Assessment and Research System (BARS) with non-computerized tests. The goal of the present study was to determine the feasibility of using standardized neurobehavioral tests in preschool and school-aged Filipino children. Test instructions were translated into the vernacular, Tagalog or Tagalog-English (''Taglish'') and some instructions and materials were modified to be appropriate for the target populations. The battery was administered to 4–6-year-old Filipino children ($N = 50$). The performance of the Filipino children was compared to data previously collected from Spanish- and English-speaking children tested in the US. The majority of children had no difficulty completing the tests in the battery with the exception of the Symbol-Digit test and Digit Span-reverse. The three groups showed similar patterns of performance on the tests and the older children performed better than the younger children on all of the tests. The findings from this study demonstrate the utility of using this test battery to assess cognitive and motor performance in Filipino children. Tests in the battery assess a range of functions and the measures are sensitive to age differences. The current battery has been utilized in several cultures and socio-economic status classes, with only minor modifications needed. This study demonstrates the importance of pilot testing the methods before use in a new population, to ensure that the test is valid for that culture.

Keywords: Neurobehavioral tests; Children; Cross-cultural; Filipino; BARS

1. Introduction

Since the late 1960s behavioral performance tests have been used to assess the effects of neurotoxic occupational exposure in adult workers (Hanninen, 1966; Stewert et al., 1968, 1969). The use of behavioral tests to assess workplace exposure has continued to increase and behavioral tests have become the most efficient methods (in terms of cost and time) to screen for adverse effects of neurotoxic exposures in adult workers (Anger, 2003; Anger et al., 1994). These workplace studies have provided us with much of the current knowledge about the effects of toxicants on human neurological functioning (Anger, 1992; Anger et al., 1993). The heightened concern over the potential impact of environmental exposures on neurological functioning in children has led to the development of neurobehavioral test batteries for use with children. There is

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a need worldwide, especially in developing countries with high levels of environmental and occupational exposures, for tools to detect adverse effects of chemicals.

1.1. Neurobehavioral effects of pesticide exposure

There is concern about the impact of pesticide exposure on neurodevelopment. This is a major public health issue because of the increasing number of children exposed to these chemicals, and the simultaneous increase in the prevalence of childhood developmental, learning, and behavioral difficulties. Children are exposed to pesticides through diet and through residential and occupational use of pesticides. Children of agricultural workers are considered to have a higher risk of exposure to pesticides compared to the general populations because of the close proximity of their homes to the fields where pesticides are applied and from take-home exposure (Fenske et al., 2002; Loewenherz et al., 1997).

Different adult populations exposed to pesticides have shown neurobehavioral deficits. Organophosphate (OP) poisoned individuals have shown a consistent pattern of deficits when compared to a non-exposed or non-poisoned population on measures of motor speed and coordination, sustained attention, and information processing speed (Reidy et al., 1992; Rosenstock et al., 1991; Savage et al., 1988; Steenland et al., 1994; Wesseling et al., 2002). Similarly, several studies have identified neurobehavioral effects in workers with long-term low-level exposure to pesticides. Neurobehavioral changes have been examined in different occupational groups chronically exposed to pesticides, including sheep farmers (Steenland, 1996; Stephens et al., 1995), green house workers (Bazylewicz-Walczak et al., 1999), tree-fruit workers (Fiedler et al., 1997), orchard pesticide applicators (Daniell et al., 1992) and cotton workers (Farahat et al., 2003). These studies have also found deficits in measures of sustained attention, information processing speed, and reaction time.

Studies examining preschool children found deficits associated with living in an agricultural community and parent's working in agriculture (Guillette et al., 1998; Handal et al., 2007; Rohlman et al., 2005). These studies were conducted in different countries and used different methods, but all showed performance deficits. An anthropological study of children in Mexico found that children living in an agricultural area showed impaired stamina, coordination, memory, and capacity to represent a familiar subject in drawings (Guillette et al., 1998). Performance differences were also seen between children in the US whose parents work in agriculture compared to those not working in agriculture on response speed and coordination (Rohlman et al., 2005). A study of children living in Ecuador found that children living in communities with a high potential exposure to pesticides because of the presence of cut-flower industry, demonstrated developmental delay compared to children living in communities with low potential exposure to pesticides and they scored lower on gross and fine motor skills and socio-individual skills (Handal et al., 2007). Furthermore there was a link between malnutrition (as measured by stunting) and worse performance.

Deficits on neurobehavioral performance associated with pesticide exposure were also seen in school-age children. Two studies examined exposure early in the child's life, either prenatally (Grandjean et al., 2006) or in the infant (Kofman et al., 2006). Children whose mother had occupational exposure during pregnancy demonstrated visuospatial deficits (increased drawing score on Stanford-Binet copying test) and higher systolic blood pressure. Stunting was also associated with a lower score on the test. Current exposure, measured by urinary metabolites was also associated with longer reaction time latencies. Children who were hospitalized as infants because of exposure to OP pesticides had impaired long-term memory compared to controls (Kofman et al., 2006). The exposed children demonstrated impairment during the acquisition phase of a verbal learning task and in inhibitory motor control. Exposure of 6-year-old children or younger to methyl parathion spraying has been associated with difficulties performing tasks involving short-term memory and attention and more behavioral and motor skill problems than the unexposed children (Ruckart et al., 2004).

By adolescence, children are often working in agriculture and exposure occurs occupationally. Studies have demonstrated performance deficits associated with children working in agriculture. Adolescent farm workers in Brazil showed impairment on several neurobehavioral measures including attention, response speed and coordination, when compared to children living in an urban area and not working in agriculture (Eckerman et al., 2006). Although the sample size was small, younger children (10–11 years old) showed more impairment than older children. Adolescents working in agriculture in the US showed impairment on cognitive tests and response speed (Rohlman et al., 2001a). Years working in agriculture and handling pesticides were also associated with worse performance in another adolescent population (Rohlman et al., 2007c). These data provide preliminary evidence of neurodevelopmental delays in children exposed to pesticides.

1.2. Neurobehavioral assessment of children

Unlike adult neurobehavioral testing, in which a number of test batteries have been developed (see Anger, 2003 for a review), there have been very few attempts to develop specific neurobehavioral batteries for children. The Pediatric Environmental Neurobehavioral Test Battery or PENTB (Amler and Gibertini, 1996) is a test battery developed to assess possible neurotoxic effects in children living near hazardous waste sites. Recognized experts in the fields of neurotoxicology, epidemiology, neuropsychology, pediatrics, neurology, and psychology developed the battery. It combines observational measures and questionnaires for very young children with performance measures that are introduced for preschool and school age children. Although it was first introduced in 1996, the PENTB has thus far been used in only one study of children exposed to methyl parathion (Ruckart et al., 2004). The performance measures included in the PENTB were developed for North American or European populations and need to be examined for cultural bias before being used in other populations.