Impairment of Expressive Behavior in Pediatric HIV-Infected Patients with Evidence of CNS Disease

Howard A. Moss and Pamela L. Wolters
National Cancer Institute and Medical Illness Counseling Center

Pim Brouwers
National Cancer Institute

Michael L. Hendricks
National Cancer Institute and Medical Illness Counseling Center

Philip A. Pizzo
National Cancer Institute

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Rated observations of videotapes were made of 16 variables representing 5 behavioral domains (task orientation, positive social-emotional, motor skills, expressive speech, and activity) on a sample of 83 HIV-infected children. Comparisons were made on the rated behaviors between children classified as either encephalopathic or nonencephalopathic. Analyses were conducted separately for infants (M age = 1.80 years) and older children (M age = 5.15 years). The nonencephalopathic infants exhibited higher activity levels and were superior in motor and verbal skills and showed more social and emotional responsiveness than did the encephalopathic group. The older nonencephalopathic children functioned in a more adaptive and appropriate manner than did the encephalopathic children in all domains of behavior. Independently made Q-sort ratings of

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2All correspondence should be addressed to Howard A. Moss, Pediatric Branch, National Cancer Institute, Building 10, Room 13N240, 9000 Rockville Pike, Bethesda, Maryland 20892.
behaviors during developmental testing were highly correlated with conceptually congruent ratings of the videotaped behaviors.

KEY WORDS: pediatric HIV-infected; encephalopathy; behavioral ratings; impaired expressive behavior.

HIV disease in children is frequently associated with mild to severe encephalopathy that can result in profound and pervasive cognitive, behavioral, and personality changes (Brouwers, Moss, Wolters, & Schmitt, 1994). Individuals differ as to the number of functions that are affected, although typically impairments appear to occur across a broad range of behavioral modalities (Armstrong, Seidel, & Swales, 1993; Brouwers et al., 1994). The neurological bases for these changes have not been established conclusively although there is evidence suggesting multiple factors underlying the etiology and course of HIV-related encephalopathy (Armstrong et al., 1993; Belman, Brouwers, & Moss, 1992). Possible causes for disease-related behavioral changes are direct effects such as impact of the virus on the central nervous system (CNS), the release of neurotoxins in the CNS as the system's reaction to the infection, and structural changes in the brain (based on imaging studies). Some of these adverse CNS conditions may be transitory whereas others reflect permanent changes, such as basal ganglia calcifications. In this regard, the type of biological evidence of CNS disease that is present may be indicative of disease stage and the permanence, generality, and severity of behavioral compromise. For example, extensive cognitive deficits and aberrant psychological functioning in HIV have been found to be associated with quinolinic acid in the cerebrospinal fluid (CSF) (Brouwers et al., 1993) and with CT findings (Brouwers et al., 1995).

Most of the evidence of adverse behavioral outcome from HIV-related CNS disease is based on impaired performance on cognitive tests. Furthermore, data show that lowered cognitive scores can be reversed after a course of antiretroviral treatment (Pizzo et al., 1988), which suggests that under certain circumstances lowered IQ scores may be the result of some condition(s) interfering with "expression" of abilities and not necessarily because of any permanent CNS damage. Thus, the plasticity of behavior in response to treatment may provide some clues to the nature and stage of the CNS disease process.

Comprehensive sampling of the range of behavior that may be affected by HIV is important in order to establish the generality of the observed impairments and to facilitate our understanding of the extent and manner in which underlying CNS structures are compromised. Yet, documentation of those functions that might be affected by HIV tend to be limited to IQ test results, probably because of their greater availability and the routine usage of standard measures of intelligence. On the other hand, assessment of social and emotional behavioral char-
acteristics tend to be underrepresented in depicting the effects of HIV on the 
CNS, apparently because of the dearth of appropriate methodologies and the 
greater difficulty in obtaining systematic and objective data on these areas of 
functioning. Thus, the lack of objective information on social and emotional 
behaviors in HIV-infected children creates a potentially biased picture that over-
emphasizes deficits in cognitive functions as characterizing HIV-related enceph-
aloopathy in children. The restricted behavioral range that has been evaluated in 
pediatric HIV-infected patients furthermore appears to hinder comprehensive and 
systematic brain–behavior analyses.

The same bias in focusing on cognitive deficits and neglecting behavioral 
characteristics exists in studies of other childhood illnesses where there is CNS 
involvement. Numerous studies have evaluated cognitive decrements among 
children after receiving cranial radiation treatment and/or CNS chemotherapy for 
acute lymphocytic leukemia (ALL) with little consideration given to possible 
treatment-related changes in other modalities of behavior (Butler & Copeland, 
1993). Thus, again by omission, these studies of pediatric ALL patients has 
contributed to the impression that this CNS treatment effect is limited to cogni-
tive deficits.

A few studies have examined aspects of behavior, other than cognitive 
functioning, that seem to be adversely effected by HIV (Moss et al., 1994; 
Wolters, Brouwers, Moss, & Pizzo, 1995). In one study children with HIV were 
rated on a Q-sort behavioral rating procedure and those classified as encepha-
lopathic obtained significantly higher scores on rating scales measuring apathy, 
nonsocial behavior, depression, and autistic-like behavior than those classified as 
nonencephalopathic. In a study carried out by Wolters et al. (1995), expressive 
language was more compromised than receptive language abilities in both en-
cephalopathic and nonencephalopathic children with this deficit in expressive 
language being significantly greater among encephalopathic children. Additional 
studies are needed to further document and elucidate both the nature and range of 
impairments of expressive functioning among these patients, and to obtain more 
objective measures of these behavioral changes.

The research reported here was designed to investigate the effects of HIV 
encephalopathy in a range of additional behaviors. Children with severe HIV-
related encephalopathy seem to exhibit an underlying inability to engage in 
purposeful, expressive social, emotional, and goal-directed behavior which may 
be pervasive and contribute to their apparent cognitive impairments. These im-
pairments can result in diminished performance—flattened affect, impoverished 
interpersonal interactions, and either the loss or arrest of verbal and motor skills 
(Brouwers et al., 1994). Behavioral changes similar to those seen in HIV-related 
encephalopathy (Moss et al., 1994) have been noted in other infections of the 
CNS. For example, autistic-like behaviors have been observed in children and 
adults with herpes simplex encephalitis (Ghaziuddin, Tsai, Eilers, & Ghaziud-
Furthermore, a recent review stresses the importance of investigating and developing methods of assessing changes in emotional behavior associated with different forms of brain injury (Sherman, Shaw, & Glidden, 1994).

The purpose of this study was to determine objectively and systematically whether "expressive, responsive behaviors" in several behavioral domains were more impaired in encephalopathic than in nonencephalopathic HIV-infected pediatric patients. To study this phenomenon, children infected with HIV were videotaped while being presented with stimuli designed to elicit responses relevant to the behavioral domains being investigated. These responses were rated from the videotapes according to a series of behaviorally defined variables. The use of videotapes helps overcome some of the shortcomings of other methods for rating behavioral and/or personality type variables. Similar use of videotaping has been successfully employed in other types of behavioral research (Lyons-Ruth, Connell, Zoll, & Stahl, 1987; Polan et al., 1991; Wilson & Matheny, 1983). The videotaping of these behaviors offers the advantages of standardization of observational data, facilitating objectivity of evaluation by using raters blind to possible biasing information on the child, and providing a method whereby reliability of evaluation can be achieved by having two independent raters view and assess the same material.3

**METHOD**

**Subjects**

Eighty-three children with HIV-infection were studied. Most of these patients were consecutively enrolled in this research. However, for the latter stage of the data collection, only children less than 3 years of age or those with evidence of CNS disease were included in this sample. This shift in the basis for selecting cases is unrelated to the variables that were studied. The primary consequence of this change in sampling was to help even out the numbers of children assigned to the different groups used in the analyses (younger group < 2 years of age, older group > 2 years of age, encephalopathic group, nonencephalopathic group). Each child's behavior was evaluated from a videotaped session that was filmed prior to or shortly after their (< 1 week) starting on an antiretroviral treatment protocol (median of 1 day before treatment start date).

The sample was recruited from all regions of the country and consisted of children who participated in clinical protocols at the National Cancer Institute (NCI). Research nurses initially contacted the child's parent or guardian by

3The manual for the administration of videotape procedures and rating of behaviors may be obtained by writing to the first author.
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phone after the referral to discuss the study. Patients and their families that appeared eligible for the studies then visited the NCI to complete initial evaluation. Of these patients, 70 were vertically infected, 6 were infected through transfusion (5 at birth), and 7 were hemophiliacs who received contaminated blood products. The HIV-disease status of these patients had progressed to the P2 level (the level of the CDC classification system indicating symptomatic HIV infection) of the CDC (Centers for Disease Control, 1987). However, none had an acute illness, were in medical distress, or were febrile at the time of the assessment. The mean CD4% levels (the percentage of the total number of lymphocytes that are T4 immune helper cells) for the patients with encephalopathy was 10% and without encephalopathy was 22%. The mean CD4% of the overall sample was within the lower 5% of the population based on comparisons with norms from an uninfected sample (European Collaborative Study, 1992). Although CD4% levels are correlated with disease progression, there are exceptions in which children with low levels do well clinically. The characteristics of the sample are shown in Table I.

**Encephalopathy**

Each child was classified as either encephalopathic or nonencephalopathic, according to the presence of moderate to severe symptomatic neurologic disease.

<table>
<thead>
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<th>Table 1. Sample Characteristics</th>
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<td>Mean age</td>
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<tr>
<td>Route of infection (n)</td>
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<tr>
<td>Vertical Transfusion</td>
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<td>Transfusion</td>
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<td>Gender (male/female)</td>
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<td>M</td>
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<td>F</td>
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<td>Mean years parental education</td>
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<td>Nonenceph.</td>
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<td>Enceph.</td>
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<tr>
<td>Encephalopathic (n)</td>
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<tr>
<td>Mean CD4 %</td>
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<td>Mean IQ</td>
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<tr>
<td>Nonencephalopathic (n)</td>
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<tr>
<td>Mean CD4 %</td>
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<td>Mean IQ</td>
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</table>

*A CD4 % of 39 is approximately at the 50th percentile of the normative sample.*
from an independent evaluation made by senior medical investigators (physicians trained in pediatrics, infectious disease, and neurology and a neuropsychologist) in the program. This was done as part of a clinical decision-making process regarding what treatment protocol a child should be assigned to and for assessing the efficacy of a treatment. Children who were diagnosed with encephalopathy were more likely to be assigned to more aggressive treatments which were more likely to penetrate the CNS. The following criteria were central in making this decision. Unambiguous evidence and relatively severe symptoms were required in classifying a child as encephalopathic. The criteria used for encephalopathy are consistent with the recommendations of the Working Group of the American Academy of Neurology AIDS Task Force (1991). Children were classified as encephalopathic if they exhibited one or more of the following criteria: (a) Loss or delays in the acquisition of developmental milestones. Availability of this evidence was contingent on the child having reached an age where these skills should have been established. Clear loss or significant delays in developmental milestones were sufficient for classification of encephalopathy, but necessarily co-occurred with lowered developmental scores. Loss of developmental milestones consisted of marked regression or disappearance of established speech and/or locomotion skills. Delays were defined by these functions emerging at least 25% behind (in months) their expected developmental timetable. (b) IQ or developmental scores well below expected levels based on norms and medical and environmental history (e.g., parental education, SES). In general, this consisted of scores greater than 2 SDs below 100 for children under 2 1/2 years of age and 1-2 SDs below 100 for older children. This was based on age-appropriate standardized IQ tests administered at the initial evaluation (Bayley, McCarthy, & WISC-R). Of those children classified as encephalopathic, 86% had IQs below 80, 62% had IQs less than 70, and 42% had IQs less than 55. An IQ below 70, unless there was a history of any preexisting non-HIV-related condition, was sufficient to warrant being classified as encephalopathic. (c) Evidence of significant decline in abilities. This depended on the availability of historical information on the child and consisted of comparison of the results of earlier with more recent test scores and on reports from parents, schools, and referring professionals of significant loss in skills. Evidence for this criterion of encephalopathy also tended to co-occur with lower than expected current developmental scores, but was helpful in classifying children when their current scores were at a marginal level and where it was ambiguous whether or not this reflected a drop in functioning. (d) The presence of positive computerized tomography (CT) findings (enlarged ventricles, loss of white matter, cortical atrophy, and calcifications) was not used to classify encephalopathy by itself but as supplementary data to help classify cases where the other information was not definitive. This situation rarely arose, but when it did, the CT findings tended to confirm the diagnosis of encephalopathy based on the above criteria rather than reverse a preliminary decision.
Although there are certain commonalities in the presentation of encephalopathy and interrelations among symptoms (Brouwers et al., in press), there is also a great deal of individual variation as to how HIV-related CNS disease is manifested. Low neurodevelopmental scores could be the sole basis for being classified as encephalopathic, but this criterion usually was accompanied by loss of developmental milestones (particularly for younger children) or by positive CT findings. Evidence for decline in abilities was inconsistently available, but when it was it typically served as supportive data and not as an independent basis for classifying a child as encephalopathic. Although these criteria are used consistently at the NCI program, they may differ somewhat in relative emphasis at other institutions, but there tends to be unanimity as to the basic factors used for classifying HIV-associated encephalopathy in children (Working Group of the American Academy, 1991). The reliability of this classification procedure was established by having two physicians independently and blindly classify a sample of 40 HIV-infected pediatric patients on the basis of information described in the above criteria of encephalopathy.\textsuperscript{4} This reliability study resulted in a kappa coefficient of .90 (Woolson, 1987).

\textbf{Videotape Procedure}

The videotape procedure was developed for this research as a method for obtaining and objectively quantifying information relevant to the aberrant behavioral patterns observed among symptomatic, HIV-infected pediatric patients. This procedure took place in a brightly lit and simply furnished room, 15 feet \times 20 feet, in the Clinical Center of the NCI where the child previously had been administered developmental tests by the same examiner. Thus, the room and the examiner were familiar to the child. Most children, particularly those under 4 years of age, were accompanied by a parent or caretaker during the session. The child was seated, or held by the caretaker, at a table located in the center of the room. A staff member operated the camera that was mounted on a tripod, in an unobtrusive manner as possible, from a corner of the room and obtained close-up recordings of the child by zooming-in with a telephoto lens. Much of the session involved close-ups of the child’s face and body since expressiveness was a primary interest of this research.

The videotape procedure consisted of a 20- to 30-minute session in which the child was engaged by an examiner in a series of age-appropriate structured tasks designed to elicit responses relevant to the five a priori domains of behavior under investigation. These domains are (a) task-oriented behavior, (b) interpersonal-social behavior, (c) affect, (d) sensorimotor behavior, and (e) communicative behavior. Several variables were rated for each of these behavioral domains. The

\textsuperscript{4}We thank Linda Lewis and Lauren Wood for classifying whether or not these patients are encephalopathic according to the criteria described above.
variables included in each domain to be rated are listed in Table II. A total of 16
variables were each rated on a 7-point scale after observing the videotape records. A manual was designed that provides a detailed definition of each of these
variables and also defines the end and middle scale points. The definition of the
variable and the use of ratings taken into consideration the age level of the child.
The manual also describes the specific procedures to be administered to the
children that were designed to elicit behavior relevant to the respective domains.
Different tasks were used that were appropriate to the child's age and level of
functioning for the following age groups: 3–18 months; 18–30 months; 30–48
months; and for children over 4 years. For example, to assess and elicit task-
oriented and fine motor behaviors, children 3–18 months were asked to grasp a
ring and pick up and place a small pill in a bottle; children 18–30 months were
asked to stack blocks as high as they were able; children 18–30 months and 30–
48 months were given a bead-stringing task, and those over 4 years of age were
asked to trace a drawing. Approximately 12–15 tasks were administered to each
child. Other representative tasks were social interaction with parent, frolic play,
sensory stimulation, age-appropriate fine and gross motor tasks (e.g., throwing
and catching ball, skipping, drawing, puppet play, response to jack-in-the-box,
"Simon Says," reaction to pictorial incongruities, conversation, and verbal con-
struction of events). The ratings were not necessarily restricted to assessment of
reactions to specific tasks, but were based on overall behavior.

As an illustration, annotated definitions from the manual of a few of the
variables used to rate the videotapes are described below (these variables are
rated on a 7-point scale):

Persistence. This variable measures a child's sustained and continuous ef-
tort to successfully complete a task while maintaining a high standard of perfor-
ance: 1 (low persistence)—The child is indifferent and nonresponsive to the
various tasks; 4 (moderate persistence)—the child shows some interest in accu-
8
racy and mastery, but may give up before completion, accepts errors or moder-
ately accurate performance; 7 (high level of persistence)—the child strives for
perfection, works very carefully and exhibits high standards in performing tasks,
and persists until task is completed.

Positive Social Behaviors. This variable measures the degree to which a
child both initiates positive social interactions and responds positively to social
interactions from others: 1 (no positive social behavior)—The child exhibits
little to no social behavior. the child gaze averts, stares vacantly, is expression-
less, and does not smile or verbalize positively; 4 (moderate positive social
behaviors)—the child exhibits moderate or intermittent social behavior, may
show some social responsiveness after encouragement and "warm-up"; 7 (high
degree of positive social behavior)—the child frequently initiates social behav-
iors (smiles, vocalizations, and eye contact) and is highly responsive to social
overtures.

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Table II. t-Test Comparison of Younger (<2 Years) and Older (>2 Years) Encephalopathic and Nonencephalopathic Patients on the Videotaped Behavioral Ratings

<table>
<thead>
<tr>
<th>Variables</th>
<th>Task-oriented behaviors</th>
<th>Social behaviors</th>
<th>Affective behaviors</th>
<th>Sensorimotor behaviors</th>
<th>Verbal behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enceph. mean</td>
<td>Nonenceph. mean</td>
<td>Two-tailed p</td>
<td>Enceph. mean</td>
<td>Nonenceph. mean</td>
</tr>
<tr>
<td>1 Persistence</td>
<td>4.1</td>
<td>4.9</td>
<td>ns</td>
<td>3.8</td>
<td>5.6</td>
</tr>
<tr>
<td>2 Attention span</td>
<td>3.9</td>
<td>4.1</td>
<td>ns</td>
<td>3.6</td>
<td>5.0</td>
</tr>
<tr>
<td>3 Impulsivity</td>
<td>4.6</td>
<td>4.1</td>
<td>ns</td>
<td>3.7</td>
<td>4.6</td>
</tr>
<tr>
<td>4 Goal-directed behavior</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>3.5</td>
<td>5.4</td>
</tr>
<tr>
<td>5 Positive social behaviors</td>
<td>4.0</td>
<td>5.4</td>
<td>&lt; .01</td>
<td>3.7</td>
<td>6.1</td>
</tr>
<tr>
<td>6 Attachment to caregiver</td>
<td>5.8</td>
<td>6.3</td>
<td>ns</td>
<td>6.1</td>
<td>6.0</td>
</tr>
<tr>
<td>7 Compliance-cooperativeness</td>
<td>4.3</td>
<td>5.1</td>
<td>ns</td>
<td>3.9</td>
<td>5.7</td>
</tr>
<tr>
<td>8 Presence of affect</td>
<td>3.5</td>
<td>4.9</td>
<td>&lt; .01</td>
<td>3.6</td>
<td>5.5</td>
</tr>
<tr>
<td>9 Irritability</td>
<td>2.9</td>
<td>2.7</td>
<td>ns</td>
<td>3.2</td>
<td>1.5</td>
</tr>
<tr>
<td>10 Positive affect</td>
<td>3.7</td>
<td>4.8</td>
<td>ns</td>
<td>3.4</td>
<td>5.6</td>
</tr>
<tr>
<td>11 Activity level</td>
<td>2.8</td>
<td>4.1</td>
<td>&lt; .001</td>
<td>3.5</td>
<td>5.1</td>
</tr>
<tr>
<td>12 Reactivity</td>
<td>3.4</td>
<td>3.4</td>
<td>ns</td>
<td>3.5</td>
<td>3.9</td>
</tr>
<tr>
<td>13 Fine motor skill</td>
<td>3.6</td>
<td>5.3</td>
<td>&lt; .001</td>
<td>3.6</td>
<td>6.0</td>
</tr>
<tr>
<td>14 Gross motor skill</td>
<td>2.7</td>
<td>5.0</td>
<td>&lt; .001</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td>15 Use of verbal language</td>
<td>1.7</td>
<td>3.6</td>
<td>&lt; .01</td>
<td>3.0</td>
<td>5.9</td>
</tr>
<tr>
<td>16 Quality of speech</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>3.6</td>
<td>4.7</td>
</tr>
</tbody>
</table>

<sup>a</sup>Not rated for younger patients.

<sup>b</sup>Not rated for children less than 12 months of age. *n* = 18 for younger patients
The videotapes of the 83 children were rated on the 16 variables defined in the manual by a clinical psychology doctoral student, trained in the rating system, who was unfamiliar with the children and was blind to whether they were classified as encephalopathic or nonecephalopathic. To establish interrater reliabilities two psychologists independently also rated the videotapes of 18 of those patients who were rated by the primary rater. The intraclass correlations (Bartko, 1966) between the raters for the 16 variables ranged from .79 to .99 with a median interrater reliability coefficient of .92. All of the variables had sufficiently high reliabilities to warrant inclusion in the analyses.

Analyses were computed separately for children less than 2 years ($M = 1.08$, $N = 35$) and those greater than 2 years ($M$ age = 5.15, $n = 48$) of age. This division into two age groups was done since 2 years of age is an important transition point associated with major developmental changes (walking, language, etc.) and several of the variables rated from the videotapes were defined differently for younger and older children. Children less than 2 years were not rated on Variable 4 (goal-directed behavior) and 16 (quality of speech) and children less than 12 months were also not rated on Variable 15 (verbal language).

The ratings of the videotaped behavioral domains (summary scores for clusters of related variables) were correlated with a separate set of ratings made by staff members of behaviors observed during developmental (Bayley, McCarthy, and WISC-R) and neuropsychological testing (PPVT, Ravens, Visual Motor Integration, etc.) of these patients. The ratings of the behaviors observed during testing were made by psychologists using a Q-sort rating procedure (NIH Child Q-sort) designed and validated to assess possible patterns of aberrant behaviors that tend to characterize encephalopathy among HIV-positive pediatric patients (Moss et al., 1994). This Q-sort procedure is based on 49 items of behaviors listed in DSM-III-R (American Psychiatric Association, 1987) to describe behavioral disorders in children. Scales were derived through factor analysis of ratings made on a sample of 180 children infected with HIV. The NIH Q-sort scales, similar to the video ratings, were developed separately for the same younger (< 2 years of age) and older (>2 years of age) age groups. The respective Q-sorts yield scores on five scales for the younger patients and scores for four scales for the older patients. The five scales for the younger group are defined as (a) Nonsocial, (b) apathy, (c) immature/poorly integrated, (d) flaccid, and (e) Attentional deficit; and the four scales for the older group as (a) Depressed, (b) Hyperactive/attentional deficit, (c) Autistic, and (d) Low frustration threshold. The videotaping and neuropsychological testing were both completed within a 5-day period. The ratings from the videotapes and the Q-sort were done independently by different raters.
RESULTS

Comparisons Between Encephalopathic and Nonencephalopathic Groups on 16 Variables

Table II presents the means and the t-test significance levels for the differences between the encephalopathic and the nonencephalopathic patients for the 16 variables that were rated. The variables are organized and listed according to the five behavioral domains described in the Method section: task oriented, interpersonal, affective, sensorimotor, and verbal. The findings are presented separately for the younger and the older patients.

Younger Group. The nonencephalopathic younger patients exhibited significantly higher Activity levels and were superior in Fine and Gross Motor and Verbal skills, and showed more responsiveness in "positive social behavior" and greater "expression of affect" than did the encephalopathic group. In contrast, encephalopathic and nonencephalopathic infants did not differ in any of the "task-oriented behaviors" or on the ratings of several of the other Interpersonal and Emotional variables. The greatest difference between the encephalopathic and nonencephalopathic infants was found in the sensorimotor domain.

Older Group. In 13 out of the 16 comparisons, the older nonencephalopathic children obtained significantly higher ratings, demonstrating more mature, integrated, appropriate, and skilled behaviors than encephalopathic children from this age group. The three variables that did not differentiate between the encephalopathic and nonencephalopathic older groups included: Impulsivity, Attachment, and Reactivity. Thus, older nonencephalopathic children functioned in a more optimal manner than did the encephalopathic patients in the task-oriented, interpersonal-social, affective, sensorimotor, and verbal behavioral domains.

Construction of Summary Domains. The 16 variables were summarized into five domain scores by identifying and pooling clusters of variables that were conceptually cohesive and exhibited high intercorrelations based on the total sample. This resulted in five revised domains that overlapped greatly with, but still were somewhat different from, the five proposed a priori domains. In the realignment of domains, several of the social and emotional variables (positive social behaviors, compliance-cooperativeness, presence of affect, and positive affect) were highly intercorrelated and thus were pooled to constitute the "positive social emotional domain," whereas others with low intercorrelations from these groupings were deleted. Activity level represented an independent and robust aspect of behavior and as a single variable was retained as a separate domain. Fine and Gross Motor skills were highly correlated and scores for these variables were summarized into the Motor Skills domain. Since the variable,
“quality of speech,” was not rated for the younger group and only 18 out of 35 of these patients (those > 12 months of age) were rated on “use of verbal language.” The Expressive speech domain was based on limited data for this group and consequently this measure was not included in all analyses. The average intercorrelations among the variables within the (a) task—oriented, (b) positive social-emotional, (c) motor skill, and (d) expressive speech domains were .72, .66, .82, and .75, respectively.

Correlations Between Domains. Summary correlations between domains were obtained by averaging all the correlations between variables from each domain with variables from the other domains in order to demonstrate the degree of overlap and independence between domains. The summary correlations are presented separately in Table III for the younger and older children. For the younger patients most of the correlations between domains were low to moderate in magnitude. The two exceptions for this group were that expressive speech was highly correlated with motor ability \( (r = .86) \) and with activity level \( (r = .70) \). Most of the correlations between domains for the older group were in the moderate range \( (rs \text{ ranged from } .37 \text{ to } .54) \) except, as was the case with the younger patients, expressive speech and motor ability were highly correlated \( (r = .69) \).

Task-orientation and activity level were unrelated for the older group.

Comparisons Between Encephalopathic and Nonencephalopathic Groups (ANOVA)

Scores for each of the domains were derived by obtaining the average rating for each subject for all the variables that comprised the domain. These scores were in turn compared for the encephalopathic and nonencephalopathic patients for both younger and older children.

Table III. Intercorrelations Between Domains: Intercorrelations of Younger Patients \( (n = 35) \) Are Shown Above the Diagonal and Older Patients \( (n = 48) \) Are Shown Below the Diagonal

<table>
<thead>
<tr>
<th>Domain</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task-oriented</td>
<td></td>
<td>.54*</td>
<td>.17</td>
<td>.24</td>
<td>.21</td>
</tr>
<tr>
<td>Social/emotional</td>
<td>.40*</td>
<td></td>
<td>.32</td>
<td>.55*</td>
<td>.51*</td>
</tr>
<tr>
<td>Motor</td>
<td>.49*</td>
<td>.51*</td>
<td></td>
<td>.86*</td>
<td>.41*</td>
</tr>
<tr>
<td>Speech*</td>
<td>.46*</td>
<td>.54*</td>
<td>.69*</td>
<td></td>
<td>.70*</td>
</tr>
<tr>
<td>Activity</td>
<td>.08</td>
<td>.53*</td>
<td>.51*</td>
<td>.37*</td>
<td></td>
</tr>
</tbody>
</table>

\( n = 18 \)

\( p < .05 \), two-tailed.

\( p < .01 \), two-tailed.

\( p < .001 \), two-tailed.
A two-way repeated measure ANOVA (comparing the five domain scores for patients classified as either encephalopathic or nonencephalopathic) for both age groups was used with the Greenhouse–Geiser correction for correlations between measures (Watemaux, 1991).

**Younger Group.** For comparisons involving the young group the expressive speech domain score was not included since the small number of patients obtained on this measure for this group disproportionately reduced the number of cases in the overall analyses. An ANOVA indicated that in the younger group the encephalopathic patients were rated significantly lower overall than the nonencephalopathic patients on the domain scores, \( F(1, 33) = 11.76, p < .01 \). There also was a significant interaction between domain scores and encephalopathy in which motor skills and activity differentiated more between encephalopathic and nonencephalopathic patients than did task-oriented and positive social-emotional behaviors, \( F(3, 3) = 4.10, p < .01 \).

**Older Group.** An ANOVA comparing the older encephalopathic and nonencephalopathic patients on the domain scores resulted in a significant effect, \( F(1, 45) = 45.75, p < .001 \), showing that the older encephalopathic children were impaired on all behavioral modalities. There was no interaction, \( F(4, 4) = \text{ns} \), when comparing each of the domain scores for the encephalopathic and nonencephalopathic patients. Thus, for this group, none of the domains differed from one another in discriminating between encephalopathic and nonencephalopathic patients. Table IV shows the means and \( p \) values for post-hoc \( F \)-test comparisons between encephalopathic and nonencephalopathic patients on the domain scores for the younger and older groups.

**Post-Hoc F-Test Comparisons for Younger Group**

For the younger group the motor skill, activity level, and positive social-emotional scores showed significant differences between the encephalopathic and nonencephalopathic patients, reflecting greater activity, motor skill, and more appropriate behavior among the nonencephalopathic infants. Only the Task-oriented domain did not statistically differ for the encephalopathic and nonecephalopathic younger patients.

**Post-Hoc F-Test Comparisons for Older Group**

All five behavioral domains exhibited statistically significant differences in the post-hoc comparisons between the older encephalopathic and nonencephalopathic children.
Table IV. F-Test Comparisons of Younger (<2 Years) and Older (>2 Years) Encephalopathic and Non-encephalopathic Patients on Clusters (Domains) of the Videotaped Behavioral Ratings

| Clusters | Younger patients (n = 35) | | Older patients (n = 48) | |
|----------|--------------------------|--------------------------|
|          | Enceph. mean | Nonenceph. mean | df | p< | Enceph. mean | Nonenceph. mean | df | p< |
| 1. Task-oriented behavior (Variables 1, 2, 3, 4) | 4.2 | 4.5 | 1.33 | ns | 3.7 | 5.2 | 1.45 | .001 |
| 2. Positive social-emotional (Variables 5, 7, 8, 10) | 3.8 | 4.9 | 1.33 | .02 | 3.6 | 5.6 | 1.45 | .001 |
| 3. Motor skills (Variables 13, 14) | 3.2 | 5.2 | 1.33 | .001 | 3.3 | 6.1 | 1.45 | .001 |
| 4. Expressive speech (Variables 15, 16) | — | — | — | — | 2.9 | 5.3 | 1.45 | .001 |
| 5. Activity (Variable 11) | 2.8 | 4.1 | 1.33 | .001 | 3.5 | 5.1 | 1.45 | .001 |
Correlations Between Behaviors Evaluated from Videotape and Q-Sort Procedures

The intercorrelations between the videotaped behavior domain scores and the Q-sort scale scores are shown in Table V for the younger patients and Table VI for the older group.

**Younger Group.** The Q-sort scale that measures Nonsocial behavior was significantly correlated with low positive social-emotional behavior and low activity on the videotaped ratings; Apathy on the Q-sort was associated with poor motor skills and low activity on the videotape ratings; and being evaluated as Immature/poorly integrated on the Q-sort was related to low task-oriented and low positive social-emotional functioning on the video ratings. The significant correlations that occurred between scores on these procedures tended to be between conceptually related variables.

**Older Group.** The Q-sort scale measuring Depression was negatively correlated with the videotape ratings on positive social-emotional behavior, expressive speech, and activity level; the Q-sort ratings of Hyperactive/attentional deficit was associated with low task-oriented behavior, but with high activity level ratings from the videotapes; and the Q-sort rating of Autistic behavior was inversely related to the ratings of all the videotaped behavioral domains, but particularly for social-emotional behavior, motor skill, and expressive speech. The Q-sort ratings on Low frustration threshold were unrelated to any of the videotaped behavioral domains. Again, the significant correlations that emerged between these two sets of behavioral ratings tended to be between conceptually congruent dimensions.

### Table V. Correlations Between the Videotape Behavioral Cluster Scores and the Q-Sort Scores for the Younger Patients (<2 Years of Age)

<table>
<thead>
<tr>
<th>Videotaped behavioral domains</th>
<th>Nonsocial</th>
<th>Apathy</th>
<th>Immature/poorly integrated</th>
<th>Flacid</th>
<th>Attention deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task-oriented (Variables 1, 2, 3, 4)</td>
<td>-.32</td>
<td>.07</td>
<td>-.40*</td>
<td>.04</td>
<td>.12</td>
</tr>
<tr>
<td>Positive social-emotional (Variables 5, 7, 8, 10)</td>
<td>-.50*</td>
<td>-.16</td>
<td>-.37*</td>
<td>-.03</td>
<td>-.11</td>
</tr>
<tr>
<td>Motor skills (Variables 13, 14)</td>
<td>-.23</td>
<td>-.51*</td>
<td>-.23</td>
<td>-.13</td>
<td>.10</td>
</tr>
<tr>
<td>Expressive speech (Variable 15)</td>
<td>-.25</td>
<td>-.20</td>
<td>-.08</td>
<td>.08</td>
<td>.07</td>
</tr>
<tr>
<td>Activity (Variable 11)</td>
<td>-.49*</td>
<td>-.65*</td>
<td>-.25</td>
<td>-.13</td>
<td>.05</td>
</tr>
</tbody>
</table>

*p < .05, two-tailed.

*p < .01, two-tailed.

*p < .001, two-tailed.
Table VI. Correlations Between Videotaped Behavioral Cluster Scores and Q-Sort Scale Scores for the Older Patients (>2 Years of Age)

<table>
<thead>
<tr>
<th>Videotaped behavioral domains</th>
<th>Depression</th>
<th>Hyperactive/attentional deficit</th>
<th>Autistic</th>
<th>Low frustration threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task-oriented (Variables 1, 2, 3 and 4)</td>
<td>.09</td>
<td>-.43&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.29</td>
</tr>
<tr>
<td>Positive social-emotional (Variables 5, 7, 8 and 10)</td>
<td>-.36&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.10</td>
<td>-.51&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-.22</td>
</tr>
<tr>
<td>Motor skills (Variables 13 and 14)</td>
<td>.27</td>
<td>-.07</td>
<td>-.78&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-.27</td>
</tr>
<tr>
<td>Expressive speech (Variables 15 and 16)</td>
<td>-.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.14</td>
<td>-.65&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-.18</td>
</tr>
<tr>
<td>Activity (Variable 11)</td>
<td>-.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.45&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-.44&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.09</td>
</tr>
</tbody>
</table>

<sup>a</sup>p < .05, two-tailed.  
<sup>b</sup>p < .01, two-tailed.  
<sup>c</sup>p < .001, two-tailed.

DISCUSSION

Several statistically significant differences were obtained from comparisons of encephalopathic and nonencephalopathic HIV-infected younger and older groups on ratings of expressive behaviors, based on videotaped behavioral samples. Both younger and older children who were nonencephalopathic demonstrated more appropriate behavior than their same-age encephalopathic counterparts. However, some of these differences were less clearly defined in the younger group, possibly because of methodological limitations of the assessment procedure or developmental characteristics of this age group. The older nonencephalopathic children obtained significantly higher scores on the task-oriented domain than did the encephalopathic patients from this age group. A similar difference on this domain was not observed for the younger group, presumably because children at this age level may not yet have matured sufficiently for behaviors such as persistence and attention span to be notably relevant aspects of their functioning. It is also possible that the tasks we used and our methods of assessing these variables were not designed and adapted appropriately to this age group. A further example of how developmental factors could have contributed to the different findings for the younger and older groups for these variables is that crying (irritability) may be an appropriate and adaptive behavior for infants (< 2 years of age) in order to communicate discomfort and provoke relief responses from the caregiver. Thus, sick infants who may not be
feeling well may exhibit elevated levels of irritable behavior, regardless of CNS status. Conversely, irritability is a more extreme and atypical reaction for older children and therefore its presence may be a more sensitive indication of aberrant functioning for this age group. The nonencephalopathic patients exhibited significantly higher domain scores on activity levels and motor skills that the encephalopathic patients for both the younger and older age groups. Expressive speech was better in the nonencephalopathic patients in both age groups with these differences again being stronger among the older children. Since expressive speech is still emerging and not yet present in many of the younger infants (and often not evaluable), this behavior may not be as sensitive in reflecting CNS disease in this group as it is in older children. In any case, the more salient differences observed in the older group should not be regarded as indicating that encephalopathy is more severe among older children. Developmental theory and previous research suggests that the CNS of younger children actually might be more adversely affected than that of older children by the HIV. For example, CNS prophylactic radiation for treating ALL resulted in greater intellectual impairment among younger compared to older children (Moss, Nannis, & Poplack, 1981). Thus, the less mature brain may be more vulnerable to deleterious events. Unfortunately, our research was not designed to properly test for age effects.

Overall the ratings of the videotaped observations show that several modalities of expressive behavior are impaired in pediatric patients with HIV-related CNS disease. Children with severe HIV-related CNS disease seem less able to take initiative and act in a purposeful way, may be unresponsive socially and emotionally (may stare vacantly ahead with little change in facial expression), have impaired motor functioning, are inactive, apathetic, and exhibit a decrement or absence of verbal behavior. There is no indication that this lack of expressiveness reflects any underlying motivation or emotional state, but rather seems tied to behavioral impotence or loss of efferent functioning. Support for a neurological explanation of this aberrant behavioral pattern comes from the finding that normal behavior can often be at least partially restored after a course of antiretroviral treatment for a drug that crosses the blood–brain barrier (Brouwers et al., 1990; Pizzo et al., 1988). Also, it was found that more severe CT scan abnormalities were significantly correlated with greater deficiency in expressive compared to receptive language scores in encephalopathic children (Wolters et al., in press). There is evidence from several sources that HIV infects the CNS and results in a variety of neurological symptoms and impairments (Armstrong et al., 1993; Belman et al., 1985).

The loss and/or impairment of expressive functions often appears to happen concurrently for several behavioral modalities. This may account for the correlations among the domain scores. Many of the 16 variables are intercorrelated, as was the case with the domain scores. Data were presented on each of the 16 variables, even though they are intercorrelated, because the various behaviors
that are represented often are regarded as conceptual entities in clinical evaluations, so that it seems useful to show how they are independently affected by HIV-related CNS disease. There is a precedent in psychology, largely for conceptual reasons, to retain individual variables as separate measures (indices) of behavior, even when they are highly intercorrelated (Kagan & Moss, 1962; McCarthy, 1972; Wechsler, 1974). It is difficult to ascertain whether the intercorrelation among variables in the present case reflects a lack of conceptual differentiation in the definitions of the variables or whether the CNS disease affects many functions in a concurrent, generalized manner. The same rationale is used to defend the use of the five derived behavioral domains which were also intercorrelated. The condensing of the variables into domains seems useful and appropriate since the 16 variables were reduced to a statistically more manageable number of summary measures while still retaining the original proposed conceptual organization. Verbal expression and motor skills are highly intercorrelated in this population, yet they represent distinctly different behavioral systems. A hypothesis we have considered, and are investigating currently, is that the high correlation between these domains may be because HIV-related CNS disease in children tends to affect these functions concurrently. These systems appear to be somewhat intercorrelated in noninfected children as well, as is reflected in the mean correlation across different ages (r = .45) between the Verbal and Motor Scales of the McCarthy Scales of Children’s Abilities (McCarthy, 1972). There may be some circularity between behavior on these two domains and the criteria for encephalopathy, particularly for the younger group, since verbal and motor skill are included as evidence of developmental status in the tests we used for assessing this age group.

The Q-sort behavioral ratings, made from observations of these children when they were administered IQ and neuropsychological tests, were highly correlated with conceptually congruent domain scores from the ratings of the videotapes. The fact that conceptually similar variables from these two procedures were highly intercorrelated, whereas conceptually divergent variables were unrelated, provides strong support for the validity of both procedures. These findings not only corroborate the sensitivity of these two procedures in differentiating encephalopathic and nonencephalopathic pediatric HIV patients but also provide evidence of the validity (construct validity) of the conceptual structure of these methods since similarly defined constructs were correlated across methods. The cross-situational generality of our findings could have been further extended if we had obtained parental ratings of comparable child behavior.

Since this research focused on behavioral manifestation of HIV-related encephalopathy it seems unlikely that factors such as length of illness, route of infection, or sampling or recruitment procedures may have influenced the obtained findings. However, this is an assumption that cannot be concluded from our data since length of illness and route of infection were not controlled for in
this investigation. This assumption could best be tested in the future through a longitudinal design where these factors could be better controlled for and monitored over the course of the illness. Moreover, our groups were heterogeneous as to such factors as race, sex, SES, CD4 status, and so forth, and although we have no basis for assuming that they contributed to our findings we cannot rule them out. The unevenness of the distribution of these groups, and the resulting small samples makes analyses in which we control for these factors impractical at this time. It also seems unlikely that situational factors, social anxiety, or emotional reactions (anxiety or depression) could have produced these findings since there is no ostensible reason for these variables to differ for the encephalopathic and nonencephalopathic groups. Furthermore, the behavioral manifestations of encephalopathy that were observed were more extreme and aberrant than is typical for the above events. However, these assumptions also warrant further, direct testing. Profound behavioral changes similar to what we described have been observed among other HIV-infected children with encephalopathy as well as in other CNS disorders, so that there is some corroboration of this phenomenon from other samples (Armstrong et al., 1993; Lifschitz, Hanson, Wilson, & Shearer, 1989; Sherman et al., 1994). There was slight variation as to how close to the treatment start dates the videotaped sessions were conducted. This variation should have had no or little effect on our findings and at the most might have resulted in minimal error variance.

Rating behavior recorded on videotapes is a very effective and useful approach. This methodology allows the investigator to stage events and interactions so that behaviors are elicited that are relevant to the dimensions one is interested in studying. The same stimulus event also can be used and videotaped across subjects so that the information that is obtained is standardized. Most important, an unbiased reviewer can view the videotapes and make the ratings independent of other information. In addition, the use of videotapes is advantageous because the same information is available to anyone viewing the tapes so that two or more individuals can independently rate the videotapes in order to establish interrater reliabilities and the tapes are a permanent record that provide a reservoir of behavioral data that can be restudied and reanalyzed as new hypotheses emerge. Some additional advantages of the videotape procedure which seems to have special relevance for children who are HIV-positive are the videotaping is an informal and relaxed procedure where information can be collected without the pressure and stress of more structured tests, it provides a compelling visual record which can be very useful for educational and communication purposes, and copies of cassettes can be made available to parents.

The impetus for this research was to delineate and document the range of behavioral impairments associated with HIV-related CNS disease. Based on our clinical observations we focused on evaluating possible decrements in expressive functions. Since no adequate methodology existed for objectively studying these
behaviors among HIV-positive children, we designed the videotape procedure to implement these research objectives. This study demonstrates that impaired expressive behavior in HIV-infected children tends to be global, across a range of behavioral modalities. In particular, motor and language abilities appear to be mutually compromised, which has implications concerning the likely pervasive effects of HIV on the central nervous system. These findings could have been further solidified and strengthened if we had included a noninfected control group. This should be a goal of future related research.

The videotape procedure has apparent applicability for studying other aspects of HIV disease in children. For instance, this methodology seems appropriate for evaluating possible behavior changes (improvement) after a course of antiretroviral treatment. Since many of the children we studied were not given follow-up video evaluations or were assigned to a variety of therapies, it was not practical or feasible to study longitudinal behavioral change with our sample in regard to specific antiretroviral treatments at this time. However, a study has been initiated using videotapes (Platt, 1993) to evaluate possible behavioral changes in a large cohort of HIV-positive children receiving a standard antiretroviral agent. These children will be videotaped and rated using the described methodology, both prior to and again after 4 months of therapy.

Our findings are consistent with the assumption that HIV-related encephalopathy in children may be associated with a general loss in expressive behavior. On the other hand, these results do not address whether internalized ideation or cognition underlying these expressive behaviors remain intact. In this regard, Ekman (1993) concluded that "there is evidence that people may show no change in visible facial activity even though they report feeling emotions and manifest changes in autonomic nervous system activity. In turn, our observation that encephalopathic patients exhibited reduced facial expressiveness does not necessarily indicate a reciprocal absence of any covert affective experience. This is an open question that still needs to be addressed for this population as well as for other nosological groups in which reduced facial expressiveness (often labeled flattened affect) may have a neurological basis.

REFERENCES


Behavioral Impairments in Pediatric HIV Patients


