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Caregivers' depressive symptoms and parent-report of child executive function among young children in Uganda

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Abstract

Maternal mental health (particularly depression) may influence how they report on their child's behavior. Few research studies have focused on Sub-Saharan countries where pediatric HIV concentrates and impacts child neuropsychological development and caregiver mental health. We investigated the associations between caregivers' depressive symptoms and neuropsychological outcomes in HIV-infected (n=118) and HIV-exposed (n=164) Ugandan children aged 2–5 years. We compared performance-based tests of development (Mullen Scales of Early Learning, Color Object Association Test), to a caregiver report of executive function (Behavior Rating Inventory of Executive Function, BRIEF). Caregivers were assessed with Hopkins Symptom Checklist-25 depression subscale. The associations between all BRIEF indices and caregiver's depression symptoms were differential according to child's HIV status. Caregivers with greater depressive symptoms reported their HIV-infected children as having more behavioral problems related to executive functioning. Assessment of behavior of HIV-infected children should incorporate a variety of sources of information and screening of caregiver mental health.

Keywords

HIV/AIDS; neuropsychological assessment; children; development; depression

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1. Introduction

Increased access to antiretroviral treatment (ART) for children in low-income countries has significantly impacted the prognosis for HIV infected children with the result that more children with HIV/AIDS survive to adolescence and adulthood (Anon, 2012). This improvement in therapeutic outcomes has changed the needs of the pediatric HIV/AIDS population with an emphasis on their quality of life, day-to-day functioning, and transition to adulthood.

As a result of the generalized HIV-epidemic in Uganda approximately 190,000 children aged 0–14 are living with HIV (UNAIDS, 2012). HIV-infected children in low-income countries are now able to survive longer but are often exposed to multiple developmental risk factors including poverty, malnutrition, disease, poor home environment, and diminished care by HIV-infected caregivers that adversely affect their ability to reach their developmental potential (Grantham-McGregor, Cheung, Cueto, Glewwe, Richter & Strupp, 2007). Consequently, neuropsychological development is rapidly becoming an important component of pediatric HIV care and research. Cognitive and behavioral development in HIV-infected children is emphasized because early childhood is frequently identified as a point of entry on a pathway of increasing risk for later cognitive difficulties (Laughton, Cornell, Boivin & Van Rie, 2013).

Multiple neuropsychological and behavioral tests are available and have been successfully used to screen or assess cognitive development in children in low-income settings, including sub-Saharan Africa (Boivin et al., 2013) and Asia (Black et al., 2007). In these assessments, caregivers remain essential informants of child health outcomes. Parental observations of behaviors are particularly important for young children who do not posses the linguistic, motor, or sustained attention skills commonly involved in performance-based measures. However, parental mental health may influence how they report information about their children, particularly maternal depression. Maternal depression has received considerable attention for its association with child behavioral and emotional outcomes, with substantial evidence documenting a significant risk to children for internalizing and externalizing problems and general psychopathology (Goodman, Rouse, Connell, Robins-Roth, Hall & Heyward, 2011). Maternal mental health also affects optimal child development; depression symptoms in the mother can place the child at risk for cognitive deficits and developmental delays (Black et al., 2007). However, how maternal depression affects mothers' report on the health and well-being of their children has been explored to a lesser extent. Several studies suggest that mothers with depressive symptoms more frequently report behavioral and cognitive problems among their children than non-depressed mothers. Based on parental reports, maternal depression predicted more severe symptom reports among depressed youngsters (Kiss et al, 2007), higher rates of symptoms of depression/anxiety and aggression (Langrock, Compas, Keller, Merchant, & Copeland, 2002), and more externalizing psychopathology (Maoz et al., 2014) in children and adolescents.

Ritchers and Pellegrini (1989) proposed the depression-distortion hypothesis as explanatory mechanism for the association of caregiver depression and child behavior and cognitive problems. In this view, the dysphoric emotions associated with depression are hypothesized

to activate a negative perceptual bias in the caregiver's ratings of child behaviors that leads to over-reporting of child adjustment difficulties. Prior reports from mostly Europe and the US support the view that depressed mothers may exaggerate behavior and function problems in their children (Hennigan, O'Keefe, Noether, Rinehart, & Rusell, 2006; Ritchers, 1992). Mixed results have also been reported, including a review which found no significant influence of parental depression on child's report of psychopathology (Ritchers, 1992), while other studies have suggested that depressed parents can be better raters of their children's psychopathology than healthy parents (Tarullo, Richardson, Radke-Yarrow & Martinez, 1995). This evidence renders caregivers as necessary but potentially fallible informants of their child's behavior and cognitive development.

Studies of the association between report of behavioral problems in children and maternal depression have predominantly been conducted in high-income settings with non-HIV affected populations (Hennigan et al., 2006; Kiss et al., 2007; Goodman et al., 2011; Maoz et al., 2014). Cultural practices on child upbringing can influence the expected behavior of the child (Yang, Kuo, Wang & Yang, 2014) and this could influence how parents perceive and rate their children's cognitive abilities. Additionally, behavioral problems can be modified cross-culturally by quality of developmental milieu and caregiving practices (Boivin & Giordani, 2009). Particularly in Uganda, there is a lack of studies focusing on the shift in child behavior perception if the caregiver is experiencing depressive symptomatology. Understanding this association in families affected by HIV is particularly important given the impact of HIV-illness on child neuropsychological development (Le Doare, Bland & Newell, 2012), higher rates of depression among adults living with HIV (Ciesla & Roberts, 2001), and negative attribution biases that may be more pronounced when reinforced by poor child health due to HIV-illness. Thus, we hypothesize that the impact of parental depression on report of child cognitive and behavioral problems may be more pronounced for families with a child who is living with HIV. With 91% of the estimated 3.4 million HIV-infected children living in sub-Saharan Africa (UNAIDS, 2012), it is especially important to assess the relationship between parental mental health and report of child behavior in this setting.

In this study we examined the associations between caregivers' depressive symptoms and neuropsychological outcomes in young HIV-infected and HIV-exposed Ugandan children by comparing performance-based tests, in which the children were directly observed by trained assessors, to a caregiver report measure of behavior. The research questions addressed in the present study are: 1) Is there an association between a caregiver's depression and ratings of her child's behavioral problems? 2) If this association is present, does its strength differ according to child's HIV status (infected versus exposed)? Because family environment has been shown to have an effect on child behavioral problems (Riley et al., 2009) and development (Black et al., 2007), we included the Caldwell Home Observation for Measurement of the Environment scale for infants and toddlers (IT-HOME) (Caldwell & Bradley, 2003) to assess the extent and nature of interactions that occur within caregiver-child dyads. We incorporated the IT-HOME assessment in a final research question: 3) does home environment modify the association between caregiver depression and their child's ratings? We hypothesized that in the context of HIV disease, caregivers with depressive symptoms would more frequently report behavior problems in their children compared to

ratings from children of non-depressed caregivers and that quality of home environment could act as moderator in this relationship.

2. Methods

2.1 Sample

This is a secondary analysis of baseline data collected from all caregiver-child dyads enrolled between March 2012 and April 2014 in a randomized controlled trial (RCT) of Mediational Intervention for Sensitizing Caregivers (MISC), in Tororo, Uganda. MISC is a one-year training program that provides caregivers with strategies for enhancing the physical and neuropsychological development of their children through day-to-day interactions at home (Klein et al., 1996; Klein & Rye, 2004). The trial is designed to evaluate the impact of the MISC intervention on improving child neurodevelopment and caregiver well-being. The MISC RCT included caregivers with an HIV-infected child (n=118) or with an HIV-exposed child (n=164), who though uninfected, was born to an HIV-positive mother. Eligibility criteria included that a caregiver was female, aged 18 or older, and be willing and able to participate in a year of MISC training. Thus, women were excluded if they had a severe mental illness or disability that would prevent engagement in training. *Caregiver* was not defined as the biological mother of the child, but rather as the adult predominantly taking care of the child. The child had to be between the ages of 2–5 years without having experienced a prior illness or injury that could have caused a central nervous system insult (including a serious birth complication or an episode of severe malnutrition, cerebral malaria, bacterial meningitis or encephalitis).

2.2 Measures

2.2.1 Child neuropsychological outcomes—Performance-based measures of child neurodevelopment are those in which there is a direct observation of the child performing a specific task. In these tests, motor, language and visual reception skills are frequently evaluated by a trained assessor using a standardized battery of tests that can include the use of props and toys. Subjective assessments of neurodevelopment, on the contrary, rely on the report of what primary caregivers, parents, or teachers observe in a child. In general, the items from a questionnaire relating to the child's behavior are read out loud to the informant, who evaluates the extent to which those behaviors describe the child.

Two performance-based tests of child cognitive development were used in this study. The Mullen Scales of Early Learning (MSEL) is a comprehensive test consisting of 124 items measuring specific developmental domains of gross motor, fine motor, visual reception, receptive language, and expressive language. Four scales (visual reception, fine motor, receptive language, and expressive language) are combined to yield the Early Learning Composite score (MELC). The MELC serves as a general measure of fluid intelligence thought to underlie cognitive ability in general (Mullen, 1995). Age-norm scores (T-scores) were obtained from normative tables in the MSEL administration manual. The MSEL has previously been adapted for use with young children in rural Uganda and has proven to be a sensitive and useful measure in this population (Busman, Page, Oka, Giordani & Boivin, 2013). Cronbach's alpha for the MSEL was 0.84.

Children were also assessed with the Color-Object Association Test (COAT), a performance-based test that uses the placement of small toys inside colored boxes to test associative (explicit) memory independent of language proficiency (Jordan, Johnson, Hughes & Shapiro, 2008). The principal outcome measures from the COAT are the immediate memory score of number of recalled items following each trial, and an overall total recall or learning score of correctly placed items presented on previous trials. The COAT has previously been adapted and used as a valid measure of memory for Ugandan children (Boivin et al., 2013). The reliability coefficient (Cronbach's alpha) of the COAT in this study was 0.80.

In addition to the above neuropsychological assessments, each child's caregiver was interviewed with the Behavior Rating Inventory of Executive Function (BRIEF) for pre-school children (1.5–5 years). This instrument is specifically designed to measure the range of executive function behaviors in children through 86-items that cover 6 primary scales (inhibit, self-control, shift, emotional control, working memory and plan/organize) that can be combined into 3 broad indices (inhibitory-self control, flexibility and emergent metacognition indices) and a global executive composite score (Gioia, Isquith, Guy & Kenworthy, 2000). BRIEF T-scores provide information about the child's individual scores relative to the scores of other respondents from a standardized sample, by age. High scores obtained on the BRIEF suggest a higher level of dysfunction in a specific domain of executive functions. Publisher copyright permission was obtained for the BRIEF and was translated into the 3 local languages (forward and backward translation) as specified by the publisher (PAR, Inc.), and the final version was approved by one of the test authors (Peter Isquith). Cronbach's alpha for the BRIEF was 0.89.

2.2.2 Hopkins Symptoms Checklist (HSCL-25), depression subscale—

Caregivers' depressive symptoms were assessed during the initial home evaluation with part II of the Hopkins Symptom Checklist-25 (HSCL-25) (Derogatis, Lipman, Rickels, Uhlenhuth & Covi 1974a and Derogatis, Lipman, Rickels, Uhlenhuth & Covi 1974b), which has 15 items assessing depression symptom. The HSCL-25 depression scale previously been adapted and validated among adults in HIV-affected Ugandan communities (Bolton et al., 2003. Caregivers were asked to report how frequently they experienced 15 specific depressive symptoms in the prior 2 weeks using a Likert scale ranging from 0 (not at all) to 3 (all the time). All 15 items were then averaged to provide each caregiver with a depression symptom score. Higher scores indicate more depressive symptomatology, with cut-off scores of 1.03 suggesting clinically relevant depression among HIV+ women (Kaaya, Fawzi, Mbwambo, Lee, Msamanga & Fawzi, 2002). Cronbach's alpha for the HSCL-25 depression subscale was 0.73

2.2.3 Caldwell Home Observation for Measurement of the Environment (HOME)—

The Caldwell Home Observation for Measurement of the Environment scale for infants and toddlers (IT-HOME) (Caldwell & Bradley, 2003) has been previously used in Uganda (Boivin et al., 2013) as a composite measure to assess the favorability of the developmental milieu and caregiving within the child's home environment. The HOME inventory measures caregiver's quality and quantity of stimulating and supportive interactions. Assessors administered the questionnaire in the caregivers' homes. The IT-

HOME inventory has 45 items with yes/no answers that cluster into six sub-scales: 1) Parental responsivity (10 items), 2) Acceptance of child (7 items), 3) Organization of the environment (4 items), 4) Learning materials (5 items), 5) Parental involvement (4 items), and 6) Variety in experience (4 items). The total score derived from 6 subscale scores was used in the analysis.

2.3 Socio-demographic characteristics

In the baseline questionnaire administered as part of the MISC trial, caregivers reported their age, education, marital status, relation to the child, HIV status, and their child's age, sex. HIV status was established for children based on their clinical file at TASO or PROMOTES studies. HIV infected was defined if the child had a record of a positive test, and HIV exposed but uninfected if the test was negative. Caregiver education level was summarized as the highest level of schooling completed.

2.4 Procedures

Child-caregiver dyads living in Tororo district or nearby areas of Busia district in eastern Uganda were recruited from: 1) health centers in these districts with participating PEPFAR-sponsored prevention of mother to child transmission programs (AIDS Support Organizations or TASO), and 2) from a concluding RTC of anti-retroviral treatment (PROMOTE Study 1) at the Infectious Disease Research Collaboration (IDRC) in Tororo. After administering informed consent, child testing and caregiver questionnaires were done in one of three languages spoken in Eastern Uganda (Japhadola, Ateso, or Luganda) in a private, quiet setting in the project's office or/and at their homes. The Institutional Review Boards of Michigan State University, the School of Medicine Research Ethics Committee at Makerere University, and the Ugandan National Council for Science and Technology approved this study.

2.5 Statistical analyses

Distributions of the characteristics of HIV-infected and HIV-exposed but uninfected children, including average scores for the BRIEF, COAT and MSEL tests, were summarized and compared using t-tests, chi-square tests or Fisher's exact tests. The Pearson's correlation coefficient was used to assess the correlation between child measures (e.g., BRIEF, COAT, and MSEL) and with caregiver's depression (HSCL). General linear modeling was used to relate MSEL, COAT, and BRIEF scores to caregiver depression score, child HIV status, and covariates, which included child's age, sex and caregiver relation to child (mother versus other). To test if the association between caregiver depression and ratings of the BRIEF was different depending on child's HIV status, significance of the interaction term between caregiver depression and child HIV status was evaluated. When the interaction term was not significant, it was removed from the model, and the main effect of caregiver depression score on child outcomes was assessed. When the interaction between caregiver depression and child HIV status was significant, further modeling was conducted separately for HIV infected and HIV-exposed children to clarify the nature of the interaction and determine the role of home environment in the association between caregiver depression and child outcomes. Quality of home environment as summarized in the HOME was added as an explanatory variable to the general linear models described above. All statistical tests were

two-sided, and 0.05 level of significance was used throughout. To gauge the impact of multiple testing on the results, the Hochberg adjustment was implemented to control the false discovery rate at 0.05 level for each linear model. Since the adjustments for multiple testing are controversial, both adjusted and unadjusted results are reported. All analyses were performed in SAS version 9.4 (SAS, 2013).

3. Results

Table 1 summarizes the distributions of the characteristics of children included in the study and their neuropsychological scores at baseline. HIV-infected children were older ($t(1)$=[4–4.82], p<.01) and had a larger proportion of females ($\chi^2(1)$= [5.94], p=.01) compared to HIV-exposed but uninfected children. Non-significant differences were observed on BRIEF, COAT and MSEL scores between HIV-infected and exposed samples.

Table 2 summarizes the characteristics of caregivers according to child HIV status. As seen from Table 2, caregivers of both HIV-infected and exposed children were mostly married and HIV positive. Among caregivers of infected children, 76% were the child's biological mother compared to 92% of caregivers among exposed but uninfected children ($\chi^2(1)$= [14.60], p<.01). HSCL depression score was comparable for caregivers of HIV-infected (*Mean*=0.95, *SD*=0.45) and exposed but uninfected children (*Mean*=0.97, *SD*=0.53).

Table 3 shows the correlations among the BRIEF, COAT and MSEL measures. Overall, measures were weakly correlated with each other. Only two scales from the MSEL (receptive language and visual reception) showed a significant, albeit low, positive correlation with the COAT measure (r=0.16, p=<.01 and r=0.15, p=,.01 respectively). Depressive symptoms were weakly correlated with the Inhibitory Self-control (r=0.18, p<.01), Flexibility (r=0.18, p<.01), Emergent Metacognition scales (r=0.18, p<.01), and with the Global Executive Composite Score (r=0.22, p<.01) of the BRIEF.

Depressive symptoms in caregivers of both HIV-infected and HIV-exposed children were not associated with either COAT or MSEL scores. On the contrary, controlling for covariates, the interaction between caregiver's depressive symptoms and child HIV status was significantly related to three broad indices and the global composite of the BRIEF (Table 4). Multivariate linear models with the interaction term between caregiver's depression and child's HIV status explained a significant portion in variation of the BRIEF scores: Emergent Metacognition (R^2=0.10, $F(6, 254)$=4.77, p<.01), Inhibitory Self-Control (R^2=0.12, $F(6, 254)$=5.60, p<.01), Flexibility (R^2=0.10, $F(6, 254)$=4.83, p<.01), and the Global Executive Composite (R^2=.13, $F(6, 254)$=6.52, p<.01). The interaction between caregiver's depression score and child HIV status was statistically significant for all BRIEF indices except Emergent Metacognition (p=.08). The coefficient for the interaction term quantifies the increase or decrease in the coefficient for the depression score according to the child's HIV status. Among HIV-exposed children, the beta coefficient (slope) for depressive symptoms was smaller than the slope among HIV-infected children, reflecting significantly weaker associations between BRIEF indices and depressive symptoms for HIV-exposed children compared to HIV infected. These differences in slopes were: −6.32 (t (254)= −1.78, p=.08) for the Emergent Metacognition, −7.57 (t(254)= −2.42, p=.02) for the Inhibitory Self-

control, −7.70 (t(254)= −2.31, p=.02) for the Flexibility, and −8.57 (t(254)= −2.48, p=.01) for the Global Executive Composite.

We also present the linear regression models for BRIEF scores with main effects of caregiver depression separately by child HIV-status (infected vs. exposed). Among HIV-exposed children, caregiver depressive symptoms were not significantly associated with any BRIEF index (Table 5). In contrast, caregiver depression significantly contributed to explaining the variance in BRIEF scores among HIV-infected children (Table 6), where higher depression scores were associated with higher scores on all BRIEF scales. Emergent Metacognition (R^2=0.13, F(4, 110)=4.17, p=<.01), Inhibitory Self-Control (R^2=0.19, F(4, 110)=6.61, p=<.01), and Flexibility (R^2=0.18, F(4,110)=5.95, p<.01) scales and in the Global Executive Composite (R^2=0.21, F(145)=7.20, p<.01) from the BRIEF significantly predicted more depressive symptomatology among caregivers of HIV-infected children.

To determine if the association between caregiver depressive and executive functioning scores as indicated by the BRIEF was explained by the quality of home environment, we added HOME inventory score as an explanatory variable to the general linear model summarized in Table 6 for HIV-infected children. The strength of the relationship between caregivers' depressive symptoms and BRIEF indices did not meaningfully change when HOME inventory was added as a covariate to the model and remained statistically significant (data not shown), suggesting that quality of the home environment did not mediate the relationship between caregiver depression and BRIEF scores.

4. Discussion

Results from our study show that there were no significant differences between children exposed to and infected with HIV in any of the behavioral and cognitive measures; no differences in the depression scores of the caregivers were found either. However, caregivers' depression scores were related to the measure of child behavior (e.g. BRIEF), but not to the performance-based measures of cognition. Consistent with previous studies among non-HIV infected children (Langrock et al., 2002; Maoz et al., 2014), our multivariate analyses showed that depression scores of the caregivers were a significant predictor of the reported behavior scores only for the group of children infected with HIV. All BRIEF indices were significantly associated with caregiver's depression symptoms, suggesting that is not a particular area of executive functioning but the parent-report as a measure that is associated with the depressive symptomatology.

Standard interpretation of T-scores for the MSEL proposes that any scores at or below 7th percentile or −1.5 to −2 standard deviations below the average indicate significant delays. However, without specific norms for this Ugandan population, it is difficult to establish appropriate cut-off scores. The COAT and MSEL scores observed in our sample are within range of those reported previously among a sample of HIV-infected children from Kayunga town and surrounding districts, Uganda (80 km northeast of Kampala) (Boivin et al., 2013). The lack of association between caregiver's depressive symptomatology and the performance-based measures analyzed in this sample (e.g. COAT and MSEL) further supports the notion that caregivers may over-report concerns. This possibility should be

assessed in future research by cross-validating parental reports by administering the BRIEF to a secondary caregiver.

We hypothesized that higher levels of caregiver depressive symptoms would to lead to over-reporting of child behavior and cognitive problems. Our data supports this for HIV-infected children. Results presented here show that caregivers with more depressive symptomatology overstated their children's executive behavior symptoms. These findings can be described as consistent with the depression-distortion hypothesis based on the theory developed by Beck (1967), and since then supported in several reasonably well designed studies (Najman et al., 2000; Najman et al., 2001). In the distortion model, depressed caregivers are said to over-report child behavior problems. However, the perceptual bias related to symptoms of depression was observed for caregivers' report of behaviors in HIV-infected children. Presumably, caregivers of HIV-infected children would expect their offspring to exhibit more behavioral problems because of the HIV-status. These expectations could be amplified, leading to over-reporting, as caregivers experience higher levels of depression.

Additional evidence supporting caregiver's over-reporting of behavioral problems is the observation that depressed persons have challenges in recognizing emotional responses. Studies have shown that depressed adults are more likely to identify sad facial expressions compared to controls (Gollan, McCloskey, Hoxha & Coccaro, 2010), are more likely to interpret neutral faces as sad (Douglas & Porter, 2010), and are more likely to overestimate the severity of negative emotions (Naranjo et al., 2011). Therefore, mothers with higher depressive symptoms are likely to interpret their children's executive functions in a similar manner as above; with poor recall of aspects related to executive function and rate neutral behaviors as negative.

Given the cross-sectional design of the study, a debate to consider is that the caregiver report of executive function as summarized in the BRIEF is accurate and that there is no reporting bias. As Garstein and Scheeber (2004) explained in a sample of 69 mothers, the relationship between maternal symptoms of depression and child behavior could be explained by the negative impact of the child's behavior on family functioning and the perceived parental competence of the mother, leading to a increase in maternal self-reported depressive symptoms. Similarly, Elgar, Waschbusch, McGrath, Stewart, and Curtis (2004) found that mothers of children with high disruptive behaviors were more frustrated, fatigued and anxious. In this scenario, the performance-based tests of development used in this study (e.g. MSEL and COAT) could be limited or less sensitive to child disruptive behaviors and/or cognitive delays that occur in HIV-affected, low-income settings. The BRIEF could prove sensitive to the more pervasive executive function and higher-order neurocognitive disabilities that typify the encephalopathy associated with even clinically stable pediatric HIV disease (Boivin & Giordani, 2009). Although this is the first time that the BRIEF has been used in Uganda, this test should be well suited to detect more subtle brain injury and executive function deficits if they occur among HIV-infected children. Because the BRIEF focuses on evaluating executive function in daily activities, it represents a promising opportunity to expand the assessment of executive functioning in children in different settings and it's use should be studied further.

Previous work supports the use of the COAT and MSEL as valid and useful measures to assess development of children in Uganda affected and infected by HIV disease (Busman et al., 2013; Boivin et al., 2013). Although standardized norms for these neuropsychological measures are not available for Uganda, the standardized scores are only used for research purposes within the study sample to assess the correspondence among caregiver and child measures internally. More longitudinal investigations in the future could shed light into the mechanisms behind the association between caregiver's depression and neurodevelopment in HIV-infected children.

In contrast to our previous hypothesis, quality of home environment (as captured by the HOME inventory) did not mediate the relationship between caregiver's depressive symptoms and child BRIEF scores. HOME scores from this study are comparable to that found in previous reports from in a sample of HIV-infected caregiver-child dyads (Boivin et al., 2013), and for children affected by severe malaria (Bangirana et al., 2013). Although not associated with depression symptoms reported by caregivers, HOME score was significantly lower among HIV-infected children in our sample. Because the HOME inventory identifies parental behaviors that are important to child's cognitive development, it may be that caregivers of infected children provide less stimulating and learning opportunities to their children because of their HIV status. Over 50% of HIV infected adults, mostly females, in Uganda seeking health care have symptoms of depression (Nakasujja et al., 2010), which is likely to affect their socialization and interaction with the children, thus resulting in low HOME scores. Worrying in HIV infected mothers is associated with having an HIV-infected child (Bennetts et al., 1999). This may explain why HIV-infected children and their caregivers had lower HOME scores. Although caregivers in both groups had similar depression scores, caregivers of HIV-infected children may exhibit interactions with their children that are 'laced' with worrying and impact their HOME scores.

More research is needed to investigate possible mechanisms in the home environment responsible for the link between caregivers' depression and child executive functioning, particularly in the context of HIV. More detail on family and parenting factors not fully captured by the HOME inventory could in part explain the association between caregivers' depressive symptoms and the error portion of the estimates of child functioning. Also, this might illustrate the need of more in-depth studies of the home environment to identify culture-specific sources of variability in the quality of stimulation provided in the child's family milieu.

Cognitive abilities and behavioral issues play a pivotal role in quality of life and academic achievement, significantly shaping a child's life capacities (Bangirana et al., 2013; Forest Hodgson, Parker & Pearce, 2011). Neuropsychological evaluations are at the heart of the matter by helping determine if there are impairments, point a likely cause, and guide interventions that might be beneficial. Our results suggest that considering the mental health of the caregiver as informant of child behavior should be part of integral neuropsychological evaluations in the context of HIV disease. Evidence for the depression-related distortion is relevant for research and clinical purposes, where scientists and therapists rely on mothers as principal informants of their children.

Results presented here must be viewed with limitations. Results are based on cross-sectional data and therefore we cannot establish directionality or causality of the observed associations. Cross-sectional studies are the first step in advancing the understanding of potential causal pathways between caregivers' depression symptoms and children's executive function. Research designs that include teachers, peers, trained observers, and mental health workers can provide important information about child's behavior and enable the construction of multi-agent assessment of child development. The sample size precluded examination of the specificity of the association between caregiver's depression and neurodevelopment outcomes with child's sex, or particular caregiver type, for example.

5. Conclusion

This study contributes to the scientific literature by presenting evidence of the association between depressive symptoms and caregiver's rating of their child's executive function. Caregivers' perceptions of child functioning clearly depend not only on the child's behaviors but the caregiver's mental health status. As others have suggested before (Ordway, 2011), we conclude that researchers should incorporate a variety of sources of information (including multiple informants) to assess neuropsychological development and behavior of HIV-infected children, screen caregivers for depressive symptoms at the time of their child's assessment, and incorporate appropriate statistical methodology to account for the associations of measures within child-caregiver dyad.

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Article highlights

- We investigate caregiver depression and HIV-affected child neuropsychological assessment
- Depressive symptoms associate with caregiver-reported HIV+ child executive problems
- Depressive symptoms did not associate with objectively measured cognition in HIV-affected children
- Assessing caregiver's mental health is important in parent-report measures of neurodevelopment

Table 1

Demographic Characteristics and Summary of BRIEF, COAT, and MSEL Scores Among 282 Children Infected With or Exposed to HIV.

Characteristic	**HIV^{+} (N=118)**	**HIV-^{exposed} (N= 164)**	**Test statistic**	***p***
Age (years) *Mean (SD)*	3.23 (0.93)	2.84 (0.37)	−4.82	<0.01
Sex, N (%)				
Males	51 (43)	95 (58)		
Females	67 (57)	69 (42)	5.94	0.01
Pre-school BRIEF, *T-scores, Mean (SD)*				
Inhibitory Self-Control	65.15 (13.45)	66.31 (11.87)	0.76	0.45
Flexibility Index	60.95 (14.27)	59.82 (12.41)	−0.70	0.48
Emergent Metacognition	64.79 (15.20)	64.64 (13.42)	−0.09	0.93
Global Executive Composite	66.26 (15.08)	66.26 (13.38)	0.0	0.99
COAT scores, *Mean (SD)*				
Total Immediate score	3.62 (3.29)	3.91 (7.31)	0.40	0.66
Total score	7.67 (10.24)	7.84 (10.42)	0.14	0.89
MULLEN, *T-scores, Mean (SD)*				
Fine Motor	33.36 (14.84)	34.99 (8.58)	1.15	0.29
Expressive Language	34.15 (12.77)	35.74 (9.73)	1.18	0.26
Receptive Language	36.71 (12.10)	38.26 (8.23)	1.27	0.23
Visual Reception	31.44 (11.89)	29.86 (9.09)	−1.26	0.23
Gross Motor	27.06 (5.59)	26.30 (3.14)	−1.43	0.19
MSEL Composite	71.37 (20.27)	71.65 (10.87)	0.15	0.89
IT-HOME score, *Mean (SD)*	19.46 (2.97)	20.48 (3.18)	2.64	0.01

Note. Standard deviations appear in parenthesis next to mean.

Tests statistic is the value for the t-test in means and chi-square test for proportions, accordingly.

P-values are for the differences in means (t-test) or proportions (chi-square test)

Table 2

Demographic Characteristics of Caregivers of HIV-Infected and HIV-Exposed Children

Characteristic	Caregivers of HIV+ children (N=116)	Caregivers of HIV exposed children (N=150)	Test statistic	*p*
Age (years) *Mean (SD)*	35.71 (8.39)	34.63 (7.77)	−1.09	0.28
Relationship to child, N (%)				
Mother	88 (76)	138 (93)	14.60	<0.01
Other (Grandmother, Stepmother, Aunt)	28 (24)	11 (7)		
Marital status, N (%)				
Single	4 (3)	4 (3)	3.30	0.38
Married	77 (66)	106 (71)		
Divorced	3 (3)	6 (4)		
Separated	8 (7)	12 (8)		
Widowed	24 (21)	21 (14)		
	0 (0)	1 (1)		
Education level, N (%)				
None				
Elementary	25 (21)	36 (24)	1.63	0.99
Secondary	74 (64)	96 (64)		
Technical	16 (14)	18 (12)		
	1 (1)	0 (0)		
HIV Status, N (%)				
Positive	92 (80)	138 (92)	9.81	0.01
Negative	19 (16)	11 (7)		
Don’t know	5 (4)	1 (1)		
HSCL-25 depression score, *Mean* (*SD*)	0.95 (0.45)	0.97 (0.53)	−0.33	0.69

Note. P-values are for the differences in means (t-test) or proportions (chi-square test)

Tests statistic is the value for the t-test in means and chi-square test for proportions, accordingly.

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Table 3

Correlations Between Child Scores on the MSEL, COAT and BRIEF, and Caregiver's Depression (HSCL). COAT sub-tests: Immediate Recall (IM), Total Recall (TR). BRIEF sub-tests: Inhibitory Self-control (IS), Flexibility (F), Emergent Metacognition (EM), and Global Executive Composite Score (GEC). MSEL sub-tests: Expressive Language (EL), Receptive Language (RL), Gross Motor (GM), Fine Motor (FM), Visual Reception (VR), and MSEL Composite Score (MC).

		COAT		BRIEF				MSEL						
	Scale	**IM**	**TR**	**IS**	**F**	**EM**	**GEC**	**EL**	**RL**	**GM**	**FM**	**VR**	**MC**	**HSCL**
COAT	IM	1												
	TR	0.78**	1											
BRIEF	IS	0.07	−0.04	1										
	F	0.03	−0.02	0.55**	1									
	EM	0.03	−0.02	0.50**	0.88**	1								
	GEC	0.06	−0.04	0.84**	0.83**	0.75**	1							
MSEL	EL	0.07	0.11	−0.11	−0.13	−0.13	−0.17*	1						
	RL	0.06	0.16*	−0.02	−0.01	−0.04	−0.07	0.55**	1					
	GM	−0.04	−0.10	0.07	0.09	0.15	0.05	0.54**	0.37**	1				
	FM	0.03	0.11	−0.10	−0.05	−0.02	−0.12	0.56*	0.56**	0.40**	1			
	VR	0.06	0.15*	−0.10	−0.03	−0.01	−0.12	0.47**	0.56**	0.47**	0.57**	1		
	MC	0.07	0.15*	−0.11	−0.08	−0.07	−0.16*	0.78**	0.80**	0.53**	0.83**	0.79**	1	
HSCL	HSCL	−0.08	−0.05	0.18*	0.18*	0.18*	0.22*	0.01	0.06	0.14	0.01	−0.05	0.01	1

Note.

*p<.01,

**p<.001,

N= 280 for all analyses

Table 4

Linear Regression Analysis of BRIEF Scores and Caregiver's Depressive Symptoms, HIV Status and Other Covariates

	Emergent metacognition				Inhibitory self-control				Flexibility				Global Executive Composite			
Parameter	**β (SE)[a]**	***Std* β**	***t***	**p**	**β (SE) [a]**	***Std* β**	***t***	**p**	**β (SE) [a]**	***Std* β**	***t***	**p**	**β (SE) [a]**	***Std* β**	***t***	**p**
Age	−3.93 (1.25)	−0.20	−3.14	<0.01 *	−3.21 (1.11)	−0.18	−2.90	<0.01 *	−3.35 (1.18)	−0.18	−2.85	<0.01 *	−4.17 (1.22)	−0.21	−3.41	<0.01 *
Sex (male v. female)	−3.25 (1.71)	−0.12	−1.90	0.06	−2.27 (1.52)	−0.09	−1.50	0.14	−2.51 (1.61)	−0.09	−1.56	0.12	−3.70 (1.67)	−0.13	−2.21	0.03
Caregiver relation to child (mother v. other)	3.17 (2.47)	0.08	1.29	0.20	2.06 (2.18)	0.06	0.95	0.35	1.41 (2.32)	0.06	0.66	0.54	2.80 (2.41)	0.07	1.16	0.25
HIV status (exposed v. infected)	4.08 (3.92)	0.14	1.04	0.30	7.23 (3.47)	0.29	2.09	0.04	4.81 (3.68)	0.18	1.31	0.19	6.51 (3.83)	0.23	1.70	0.09
HSCL-25 depression score	8.52 (2.83)	0.30	3.00	<0.01 *	10.10 (2.51)	0.40	4.02	<0.01 *	9.82 (2.67)	0.37	3.68	<0.01 *	11.00 (2.77)	0.39	3.97	<0.01 *
Interaction between HSCL-25 depression score and HIV status (exposed v. infected)	−6.32 (3.54)	−0.28	−1.78	0.08	−7.57 (3.13)	−0.37	−2.42	0.02	−7.70 (3.33)	−0.36	−2.31	0.02	−8.57 (3.46)	−0.38	−2.48	0.01 *

Note.

[a] β is the regression coefficient and (SE) is the standard error in a linear regression analysis, *Std* β in the next column is the standardized regression coefficient;

* Significant after the Hochberg adjustment for the false discovery rate.

Reference categories: Males=1, Females=2, HIV-infected=1, HIV-exposed=2

Table 5

Linear Regression Analysis of BRIEF Scores and Caregiver's Depressive Symptoms and Other Covariates Among HIV-Exposed Children (N=164)

	Emergent metacognition				Inhibitory self-control				Flexibility				Global Executive Composite			
Parameter	**β (SE)** [a]	***Std*β**	***t***	**p**	**β (SE)** [a]	***Std*β**	***t***	**p**	**β (SE)** [a]	***Std*β**	***t***	**p**	**β (SE)** [a]	***Std*β**	***t***	**p**
Age	−8.61 (2.85)	−0.25	−3.01	<0.01 *	−8.41 (2.56)	−0.27	−3.29	<0.01 *	−10.64 (2.64)	−0.32	−4.08	<0.01 *	−9.76 (2.84)	−0.28	−3.44	<0.01 *
Sex (male v. female)	−5.14 (2.20)	−0.19	−2.34	0.02	−2.81 (1.97)	−0.12	−1.43	0.16	−1.67 (2.03)	−0.07	−0.82	0.41	−4.37 (2.18)	−0.16	−2.00	0.05
Caregiver relation to child (mother v. other)	1.30 (4.03)	0.03	0.32	0.75	−4.91 (3.61)	−0.11	−1.36	0.18	−5.93 (3.72)	−0.13	−1.59	0.11	−2.96 (4.00)	−0.05	−0.74	0.46
HSCL-25 depression score	1.76 (2.04)	0.07	0.86	0.39	2.38 (1.82)	0.11	1.30	0.19	1.92 (1.88)	0.08	1.02	0.31	2.19 (2.02)	0.09	1.08	0.28

Note.

[a] β is the regression coefficient and (SE) is the standard error in a linear regression analysis, *Std* β in the next column is the standardized regression coefficient.

* Significant after the Hochberg adjustment for the false discovery rate

Reference categories: Males=1, Females=2

Table 6

Linear Regression Analysis of BRIEF Scores and Caregiver's Depressive Symptoms and Other Covariates Among HIV-Infected Children (N=118)

	Emergent metacognition				Inhibitory self-control				Flexibility				Global Executive Composite			
Parameter	**β (SE)** [a]	***Std*** **β**	***t***	**p**	**β (SE)** [a]	***Std*** **β**	***t***	**p**	**β (SE)** [a]	***Std*** **β**	***t***	**p**	**β (SE)** [a]	***Std*** **β**	***t***	**p**
Age	−3.11 (1.48)	−0.19	−2.11	0.04	−2.09 (1.26)	−0.14	−1.66	0.10	−1.59 (1.35)	−0.10	−1.17	0.24	−2.99 (1.40)	−0.18	−2.14	0.03
Sex (male v. female)	−1.83 (2.76)	−0.06	−0.66	0.51	−2.76 (2.35)	−0.10	−1.17	0.24	−5.23 (2.52)	−0.18	−2.07	0.04	−4.10 (2.61)	−0.13	−1.57	0.12
Caregiver relation to child (mother v. other)	4.10 (3.21)	0.11	1.27	0.21	5.44 (2.74)	0.17	1.98	0.05	4.83 (2.94)	0.14	1.64	0.10	5.56 (3.05)	0.16	1.83	0.07
HSCL-25 depression score	8.39 (3.04)	0.25	2.76	<0.01 *	9.81 (2.59)	0.33	3.78	<0.01 *	9.76 (2.78)	0.31	3.51	<0.01 *	10.80 (2.88)	0.32	3.75	<0.01 *

Note.

[a] β is the standardized regression coefficient and (SE) is the standard error in a linear regression analysis, *Std* β in the next column is the standardized regression coefficient.

* Significant after the Hochberg adjustment for the false discovery rate

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