

Too Much Stress and Not Enough Food for Thought (or Learning)

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Abstract

Brain-based research investigating stress and micronutrient deficiencies is showing a negative impact on memory and executive functioning, both of which involve critical thinking skills needed in the academic setting. The unique population of internationally adopted children is at especially great risk of language and learning problems due to high stress and micronutrient poor environments both before and after birth. This paper explores data from 207 children adopted at the age of three years or older from a range of countries, though primarily that of Russia. A parent questionnaire was used to assess an array of variables seen as markers for stress and micronutrient deficits. Correlations, as preliminary investigation for further analyses, were run comparing these factors to language variables, including first language proficiency, comprehension and production of functional English (the second language – L2), and comprehension and production of academic English (L2). Implications for teachers – and other ELLs -- are discussed.

Introduction

There is increasing evidence, through brain-based studies, of the crucial role that both stress and micronutrient deficits exert on neurochemicals and neurotransmitters which are critical for memory and learning (Kishiyama, Boyce, Jimenez, Perry, & Knight, 2008;

Sapolsky, 2004). These findings are especially important for teachers of students of low socioeconomic status (SES), recent immigrant status, refugee status, and migrant status due to: 1) the stress of poor living conditions, lack of access – both financial and logistical – to good quality medical care, and the tenuousness of day-to-day living, especially for refugees; and 2) the lack of micronutrient dense diets, again due to lack of access, both financial and logistical (Pearson, 2014).

Students from immigrant, refugee, migrant, and low SES backgrounds often struggle in an academic setting, even with additional support services (Hamayan, Marler, Sanchez-Lopez, & Damico, 2007). Some in the educational setting go so far as to erroneously blame the student for having an assortment of problems (Hamayan et al., 2007). Yet research is showing that brain mechanisms are at play beyond the level of student control. For example, as glucocorticoid levels (neurochemicals that increase under stress conditions) increase, memory (the storing and retrieving of facts) decreases (Sapolsky, 2004). In a similar fashion, as stress in general persists, executive functioning decreases. Executive functioning occurs in the prefrontal cortex and involves what one does with those facts stored in memory – the strategizing, organizing, judging, decision-making, and impulse control so necessary in an academic setting (Sapolsky, 2004). In addition to stress, micronutrient deficiencies can also contribute to poor executive function and critical thinking skills (Bryan, Osendorp, Hughes, Calvaresi, Baghurst, & van Klinken, 2004). This is a significant concern as only 14% of the U.S. child and adolescent population consumes the recommended level of daily fruit and only 20% that of vegetables (Story & Neumark-Sztainer, 2005), the very foods that are micronutrient dense. (See Pearson, 2014, for a brief tutorial on brain function and language with an emphasis on micronutrient load.)

A unique population of second language learner that has a rather high incidence in western Michigan and other parts of the U.S.

is that of internationally adopted (IA) children. This group also experiences a range of significant stressors including poor maternal nutrition as fetuses in utero, orphanages that may have limited food and medical resources, limited educational opportunities, and lack of bonding with adults, all of which can negatively impact language acquisition and learning (Pearson, 2005, 2010). It is this unique English-as-a-second-language (ESL) population that is the focus of this research paper.

Review of Literature

Internationally adopted children

Internationally adopted (IA) children are a unique population of second language learners that arrive with a complex background of interacting variables that impact language and learning. No matter age of arrival, they frequently exhibit a broad range of delays, including language (Johnson, 1999). Though some researchers looking at infants (6-24 months at arrival) from China have not found signs of functional language delays in the early years (Roberts, Pollock, Krakow, Price, Fulmer, & Wang, 2005), there is some evidence for challenges in learning both functional and academic English for a subgroup of children who were adopted from a range of countries at greater than three years of age (Pearson, 2005, 2010).

Many children arriving from Russia and Eastern Europe, as great as 56-59%, have been found to be delayed in their first language (L1) (Albers, Johnson, Hostetter, Iverson, & Miller, 1997; McGuinness & McGuinness, 1999). In those arriving from Romania, 59% were also found to be delayed in their L1, with 33% still showing delays in language at follow-up two and a half years later (Johnson et al., 1992; Marcovitch, Cesaroni, Roberts, & Swanson 1995). In fact, 94% of IA children from Romania exhibit some type of developmental language and/or speech disorder at arrival (Rosenberg, Pajer, & Rancurello, 1992).

Since language delays can be early warning signs of other processing problems, the large percentages of children with

continuing delays, noted in the paragraph above, are of concern. For example, while five percent of U.S. children are diagnosed with learning disabilities (LDs), adopted children are four times as likely to have LDs (Brodzinsky, Schechter, & Henig, 1993; Brodzinsky & Steiger, 1991). Further, in a study comparing non-adopted with adopted children across a range of variables, it was found that 4.4% of non-adopted children needed to attend a special school in contrast to 13.2% of adopted children; 20.4% of non-adopted children repeated a grade in contrast to 24.4% of adopted children; and 22.5% of non-adopted children experienced further school problems in contrast to 38.2% of adopted children (Verhulst, Althaus, & Versluis-den Bieman, 1990). Children adopted internationally can experience even higher LD rates because of pre- and/or postnatal stress, malnutrition, and micronutrient deficiencies (Miller, 2005).

Stress

According to Miller (2005), “most international adoptees are exposed to stress pre- and postnatally” (p. 131). Stress in utero causes memory and learning problems, as well as behavior problems (areas controlled by the frontal cortex) along with metabolic syndrome and other problems later in life (Sapolsky, 2010). This very early stress, with its adverse effects on learning and memory, can have lifelong consequences, including problems with concentration, distractibility, executive function, emotional regulation, and impulse control (Miller, 2005).

Stress causes excess corticotropin-releasing factor (CRF) or corticotrophin (ACTH) that results in overproduction of cortisol, a stress hormone (Miller, 2005). Stress also alters glucocorticoid receptors which results in excessive binding of cortisol (Miller, 2005); if prolonged, these elevated glucocorticoid levels adversely affect the brain (Gunnar, 1998) and its development, specifically areas which will be needed for learning and memory (Sapolsky, 2010). For example, a pregnant woman who is under stress and experiencing anxiety—a typical situation for those who are refugees, recent

immigrants, migrants, of low SES, or considering adoption for their unborn child—releases glucocorticoids in utero which then reach the fetus. Continual exposure to these stress hormones not only leads to a decreased capacity for future learning, but also to anxious babies and children, and these effects are large (Sapolsky, 2004).

Low birth weight (LBW) has been used as a substitute marker for both stress (Sapolsky, 2004) and malnourishment (Miller, 2005) in utero. The degree of stress on the infant is even greater when prematurity accompanies the LBW (Sapolsky, 2004). In the population of IA children, LBW is common, with more than 25% exhibiting this sign of early stress (Albers, Johnson, Hostetter, Iverson, & Miller, 1997; Proos, Hofvander, Wennqvist & Tuvemo, 1992a, 1992b). The potential result is negative outcomes regarding cognitive ability, along with problems with attention, persisting into the adolescent years (Miller, 2005; O'Keefe, O'Callaghan, Williams, Najman, & Bor, 2003; Pomerance, 2003).

Postnatal stress, even into the school years, can also exert an effect. As noted in the introduction, increased glucocorticoid levels cause decreased memory (storing and retrieving facts), while increased stress in general decreases executive function (what can be done with those facts in memory). In the educational setting, what is needed are moderately elevated levels as these tend to strengthen activations in the neural networks which are necessary for memory and learning (Sapolsky, 2004). If there is no or low stimulation/stress experienced, little to no learning takes place. If too much stimulation/stress is experienced, again, little to no learning takes place. The result is an inverse U-shaped learning curve. For many students in the schools, the level of stimulation and/or stress is too high, due to factors tied in to refugee status, migrant status, low SES, and/or the pressure of learning another language concurrently with content material. For those from orphanages, the level of stress can often be exacerbated as there is no L1 to fall back on in the home, nor

are there familiar people, food, or customs even in their home environment.

Malnutrition and micronutrient deficiency

In addition to a high level of pre- and postnatal stress, many newly arrived IA children have mild to moderate malnutrition with concurrent micronutrient deficiencies (Miller, 2005); these deficiencies have long-term effects on growth, cognition, and behavior (Miller, 2005) which, as Sapolsky (2004) has also noted regarding stress, are broad. Additionally, these reductions in cognitive ability can be permanent (Miller, 2005), a fact known for many years from solid, long-term longitudinal studies (Galler & Ramsey, 1989; Galler, Ramsey, Solimano, & Lowell, 1983; Galler, Ramsey, Solimano, Lowell, & Mason 1983; Grantham-McGregor, 1993; Stoch & Smythe, 1976; Stoch, Smythe, Moodie, & Bradshaw, 1982). Areas especially susceptible to early malnutrition include memory and attention (Miller, 2005).

Both malnutrition and micronutrient deficiencies occurring from the first trimester prenatally through the first three years of life are of special concern as this is the time span most critical for brain growth. According to Miller (2005), “Prenatal malnutrition is common [with] more than 25% of international adoptees [having been] low birth weight” (155), a point supported by several research groups (Albers, Johnson, Hostetter, Iverson, & Miller, 1997; Proos, Hofvander, Wennqvist, & Tuvemo, 1992a, 1992b). Postnatally, malnutrition is also common due to poverty (a situation also seen in refugees and migrant workers) as well as institutional settings, including both orphanages and foster care (Miller, 2005). Even one (unrecorded) episode of malnutrition occurring between the first trimester through the third year of life can have deleterious effects.

While malnutrition is common in IA children, chronic undernutrition is even more prevalent and also has long-lasting effects (Miller, 2005). Children who present as adequately nourished (normal weight with adequate protein and polyunsaturated fatty acids intakes)

can experience problems in the areas of speech and language, gross motor function, and perceptual and visual motor abilities if they are deficient in any specific micronutrient. These micronutrient deficiencies, even if resolved, may exert persistent long-term negative effects (e.g., LDs and impaired school performance) even when other areas of growth have reached age appropriate levels (Miller, 2005).

Examples of some micronutrient deficiencies and their effects include iron deficiency that can cause speech and language delay, including vocabulary development; depressed cognition; and depressed motivation and attention span (Miller, 2005). As is becoming a common theme, problems may persist, to the point of being irreversible, even after supplementation (Miller, 2005). Zinc is another micronutrient that, with even a marginal deficiency, may cause developmental delay, cognitive impairment, attention deficit hyperactivity disorder (ADHD), and LDs, due to its involvement in the metabolism of neurotransmitters (Miller, 2005). Iodine deficiency can cause cognitive impairment as well, often long-term or permanent, as well as negatively impact language development, memory, numerical reasoning, and motivation (Miller, 2005). These are just a few examples of micronutrient deficiencies and their negative effects. A key point is that each rarely occurs in isolation; rather, they are often part of a constellation of general malnutrition, undernourishment, and/or specific micronutrient deficiencies, with adverse effects possibly remaining long-term or permanently after treatment (Miller, 2005).

Potential impact on language and learning in the academic setting

As has been seen so far, stress and micronutrient deficiencies have negative impacts on cognition, learning, and language. According to Miller (2005), “Language ability is often cited as the best predictor of intelligence... [yet the significance of] delays in preverbal skills may not be appreciated, although identification and remediation of this deficiency is exceedingly important” (p. 203). Further, those “with significant language delays in the first 2 years of

life rarely develop normal language” (Miller, 2005, p. 204), a concern not only for parents but also for teachers who will have these students in their classrooms. Several misconceptions about IA children and language exist (Miller, 2005). The first is that IA children have delays in language simply because they need to learn the L2, a rampant misconception in the K-12 school setting where children are denied needed assessment and services until after they have learned English, itself problematic if the underlying cause is a language learning (processing) disorder. (For discussions of assessment issues, see Hamayan et al., 2007, and Samway & McKeon, 2007). The second myth is that “internationally adopted children will catch-up with time, love, and the care of parents alone” (Miller, 2005, p. 206). Even birth children – with a lifetime of love and care from their parents - do not catch up without needed services. A disorder is not the same as a delay.

It is important to note that “recovery from language delays usually lags behind other areas” and may never completely resolve; even if it does, “many children later have learning disabilities and school related problems” (Miller, 2005, p. 209), especially reading problems (Bishop & Adams, 1990; Scarborough, 1990; Scarborough & Dobrich, 1990). This may in part be due to decontextualized language being weaker and only becoming evident by the demands of the school setting. Of concern with the population of this current study, IA children age three years or older at time of arrival will usually acquire functional English, yet this does not guarantee that proficiency with academic English will develop (McGuinness & McGuinness, 1999). If even functional English does not develop within 6-8 months after arrival to the adoptive home, children will need assessment and intensive supportive services (Gindis, 1998, n.d.; Pearson, 1997). Miller (2005), in speaking of IA children, sums up the cascading system of problems that are encountered: LDs, behavior problems, language delays, and other problems that impact school performance are caused and/or exacerbated by pre- and/or

postnatal stress, malnutrition, micronutrient deficiencies, and other factors.

Questions of this study

The general question that this current study explores is: Do markers of stress and micronutrient deficiency impact the ease or difficulty in learning English in this particular population of learners? More specifically, and not previously addressed by others, what is the impact of stress and micronutrient deficiencies on the following English-as-a-Second-Language dimensions: 1) comprehension of functional English, 2) production of functional English, 3) comprehension of academic English, and 4) production of academic English?

Method

This study on micronutrient status and stress and their impact on ESL development in IA children is an extension of previous work (for further details, see Pearson 2005, 2010). The focus of this paper is on additional variables and clustering including low birth weight, prematurity, alcohol exposure during fetal life, and general medical condition, undernourishment, underweight, and anemic status after birth.

Questionnaire

Parent report was the method of data collection selected for several reasons: 1) standardized tests for this unique population do not yet exist, nor have other tests been normed on this group (see Johnson et al., 1992, for special issues); 2) studies have shown that this method of data collection is a valid measure of children's language ability, including both lexical and grammatical milestones (Marchman & Martinez-Sussman, 2002; Rescorla & Alley, 2001); and 3) the children and their adoptive parents were from across the entire United States, making it challenging to test each child individually. The extensive questionnaire of 20+ pages sought to

gather data on medical, psychosocial, and language factors, along with support services received post-arrival to the adoptive home. Some of the material was adapted from work by Glennen and Masters (2000) and Pollock (2001). Parents completed the questionnaire after their children had been with them for one year; if it had been longer than one year since their children arrived, data was based on their children's development at the one year post-arrival point.

Participants

Participants in this current study numbered 207 internationally adopted children between the ages of three to sixteen years of age.¹ Two thirds of the children were female and one third were male. This is representative of the current and past gender demographics of IA children in general (Adoption Institute International, 2004). The majority of the children (75.8%) were from Russian-speaking backgrounds (Russia, including orphanages in Ukraine, Kazakhstan, and Latvia where Russian was the primary language used with the children) with smaller numbers of children from China (speaking Mandarin) and Romania (speaking Romani) at 6.3% each. The remaining children (11.6%) were from the following countries: Guatemala, Bulgaria, Poland, India, Republic of Georgia, Cambodia, Vietnam, Portugal, and Sierra Leone. Additional demographic information includes the following: average age of arrival to an orphanage setting was 2 years ten months (2;10²), with a range of 0;1 to 11;4; average amount of time spent in an orphanage was 3;7, with a range of 0;1 to 15;10; and average age of arrival to the adoptive home was 6;5, with a range of 2;5 to 15;10.

¹ Three children were adopted prior to age three years: one at two years five months and two at two weeks prior to their third birthday.

² Convention used for ages is number of years followed by number of months. For example, a child of three years and two months would be notated as 3;2.

Variables under study

Several general factors were explored in order to better understand the demographics of this particular group of IA children. These included sex, age of arrival to an orphanage setting, amount of time spent in an orphanage, and age of arrival to the adoptive home.

Markers for stress and/or micronutrient deficiency in utero included LBW, prematurity, and alcohol use by birth mother including to such an extent that the child was later diagnosed with fetal alcohol syndrome or fetal alcohol effects. As noted previously, LBW has been used as a marker for both stress and micronutrient deficits in the general population (Sapolsky, 2004) as well as the IA population (Albers, Johnson, Hostetter, Iverson, & Miller, 1997; Proos, Hofvander, Wennqvist & Tuvemo, 1992a, 1992b). Alcohol use/abuse by the birth mother was considered important to consider because over three fourths of the children in the study were from Russian or countries of the former Soviet Union, and Russia has the highest alcohol consumption in the world, a documented toxin, with a cascade of resulting problems (Miller, 2005).

Markers for continued stress and/or micronutrient deficiency post birth included general medical condition, underweight status, evidence of undernourishment, and anemia. These were all documented at time of arrival to the adoptive home, offering evidence of continued stress and deficient diet for many years.

Language variables chosen included first language proficiency at arrival to the adoptive home as it has been shown to provide a foundation for the learning of other languages (Cummins, 1992) and several second language variables. Comprehension and production of functional English (also referred to as basic interpersonal communication skills – BICS) at one year post arrival were explored as these are the skills of most concern early on by adoptive parents who rarely speak their child's L1; additionally, functional language skills provide the foundation for expansion into academic language. Comprehension and production of academic English (also referred to

as cognitive academic language proficiency – CALP) at one year post arrival were also investigated as they are the skills needed in order to be successful in the academic setting. Since these children for the most part were already of school age upon arrival, a cushion of time for language learning prior to entry into school was not available, necessitating quickly learning an advanced level of English as well as content material.

Analyses

Bivariate correlations were used in this preliminary investigation of this unique population of children of which little is known. Though correlations simply indicate a relationship and cannot claim causation, such information is useful as a basis upon which future more robust analyses can be run. The following variables were used as measures of degrees of stress and micronutrient density: general medical condition, low birth weight, prematurity, use/abuse of alcohol by mother, undernourishment status, underweight status, and anemia.

Bivariate correlations were run on the above variables in relation to measures of language learning, both first language proficiency at time of arrival to the adoptive home and degree of ease/difficulty in learning a second language by one-year post arrival to the adoptive home. ESL measures were subdivided into the following four areas: 1) comprehension of functional English, 2) production of functional English, 3) comprehension of academic English, and 4) production of academic English.

Results

Significant correlations were found both between groups of variables – stress/micronutrient deficiency variables and language variables – as well as within each of these sets of variables. There were no significant correlations between sexes in any of the variables. Results are presented in the following order: 1) general issues of age of arrival to orphanage and length of time in orphanage in relation to

a) stress/micronutrient deficits and b) language; 2) stress/micronutrient density in relation to a) other within group variables and b) language; and 3) language variables in relation to a) other within group variables and b) stress/micronutrient density variables.

General variables

Looking first to the more general variables of age of arrival to an orphanage and amount of time spent in an orphanage, the following were found: the age of arrival to an orphanage setting was significantly negatively correlated with low birth weight (-.281**³), prematurity (-.236*), and general medical condition (-.152*), undernourishment (-.148*), and underweight (-.163*) at arrival to the adoptive home. Age of arrival to an orphanage was also significantly negatively correlated to first language proficiency (-.424**). The amount of time spent in an orphanage setting was significantly correlated with prematurity (.196*), alcohol use by birth mother (.309*), and undernourishment (.159*) and underweight (.146*) at arrival home. Additionally, amount of time spent in an orphanage setting was also significantly correlated with comprehension of functional English (.166*) and both reception (.177*) and production (.173*) of academic English.

Stress and micronutrient deficiency variables

Turning to variables indicative of high risk for stress and micronutrient deficiency, low birth weight was significantly correlated with prematurity (.589**) and general medical condition (.538**) and undernourishment (.229*) at arrival home, along with first language proficiency (.245*) and development of comprehension (.211*) and production (.198*) of functional English. Prematurity was significantly correlated with low birth weight (.589**) and

³ The following conventions are used: * to indicate p value $\leq .05$ and ** to indicate $p \leq .01$ levels.

general medical condition (.443**) and underweight (.255*) at arrival home; no significant correlations were found with language variables. Maternal use/abuse of alcohol during pregnancy to the point of fetal alcohol syndrome/effects was significantly correlated with general medical condition at time of arrival home (.302**), as well as first language proficiency (.263**). General medical condition, undernourishment, underweight, and anemia, all at time of arrival to the adoptive home, were similarly related with the exception of language. General medical condition at arrival home was significantly correlated with low birth weight (.538**), prematurity (.443**), alcohol use/abuse resulting in fetal alcohol syndrome/effects (.302**), and undernourishment (.348**) and underweight (.278**) at arrival home. It was further significantly correlated with first language proficiency (.209**) and all four dimensions of second language development – comprehension (.231**) and production (.167*) of functional English and comprehension (.169*) and production (.172*) of academic English. Undernourishment at arrival home was significantly correlated with low birth weight (.229*) and general medical condition (.348**), underweight (.617**), and anemia (.235**) at arrival home, along with first language proficiency (.149*) and all four dimensions of English language development (.196**, .156*, .177*, .202**). Underweight at arrival home was significantly correlated with prematurity (.255*) and general medical condition (.278**), undernourishment (.617**), and anemia (.176*) at arrival home, as well as with first language development (.223**) and all four dimensions of English language development (.250**, .199**, .157*, .166*). Finally, anemia at arrival home was significantly correlated with undernourishment (.235**) and underweight (.176*) at arrival home, as well as with first language proficiency (.189*). It was not, however, correlated with any of the ESL dimensions.

Language variables

Finally, looking at language variables, first language proficiency was correlated with low birth weight (.245*), alcohol use/abuse by birth mother sufficient to produce fetal alcohol syndrome/effects (.263**), and general medical condition (.209**), undernourishment (.149*), underweight (.223**), and anemia (.189*) at arrival home. Further, it was correlated with all four dimension of ESL development (.440**, .522**, .413**, .423**). Comprehension and production of functional English were both correlated with low birth weight (.211* and .198*, respectively) along with general medical condition (.231**, .167*), undernourishment (.196**, .156*), and underweight (.250**, .199**) at arrival home; while comprehension and production of academic English were correlated with general medical condition (.169* and .172*, respectively), undernourishment (.177*, .202**) and underweight (.157*, .166*) at arrival home. All four ESL dimensions were significantly correlated with first language proficiency (.440**, .522**, .413**, .423**) and each other (ranging from .678** to .902**).

The above correlations provide a preliminary investigation into the factors indicative of stress and micronutrient deficiency and their relationship to language development, both first and second. Clusters of variables can be seen, both expected and not, which provide a guide to future more robust analyses.

Discussion

As can be seen in the results section, numerous significant correlations were found, leading to many areas for discussion. Regarding general demographics, there were no differences found between the sexes regarding language. Literature on monolingual non-adopted children typically shows boys to lag behind in language development. The lack of findings in this study, with either the L1 or ESL dimensions might have been due to so many children having difficulty learning language or so many other factors that the sex variable was diluted.

General variables

Regarding age at arrival to an orphanage, it can be seen that the younger a child was at arrival, the more likely they were to be significantly language delayed in their L1 at arrival to their adoptive home. This may be a result of “good” children at an orphanage being those that are quiet, hence a discouragement of language development. Children arriving to an orphanage at the youngest ages also tended to be those who were LBW and/or premature at birth. This may be due to a more fragile infant being more difficult to care for and thus more likely to have been brought to an orphanage when other seemingly insurmountable problems arose. Finally the younger a child was at arrival to an orphanage, the worse their general medical condition was at arrival to the adoptive home and the more undernourished and underweight they were, even when years had been spent in an orphanage. This may be due to an interaction with their earlier LBW and/or premature status; however, it could also be that those children who stayed in a regular home, however lacking, fared better than those in an institutional setting.

Looking at amount of time spent in an orphanage, the longer children had spent in such a setting, the more likely that they had been premature or that their mother had used alcohol during pregnancy. This may be due to an interaction with age of arrival – increased problems as an infant resulted in earlier arrivals to an orphanage setting, and decreased likelihood of being adopted. The greater the time in an orphanage, the greater chance children were to be undernourished and underweight at arrival home, even though one would assume an institutional setting to have better and more regular access to food along with greater access to medical care. Finally, the longer children spent in an orphanage, the more problems they had later in learning English. This may be due to children being older at arrival to an adoptive home, and thus there being higher expectations and more decontextualized language needed in a shorter frame of time than for a child of a younger age. Miller (2005) states that the

duration of institutionalization is correlated with the prevalence of delay in infants, but after the age of three years, the situation is more complicated and may not hold. These findings, however, indicate that even for children three years and older at arrival home, there are significant correlations between prevalence of delay in language skills and amount of time in an orphanage setting. This finding is interesting in that Sapolsky (2004) has noted that for children in Romanian orphanages for at least a year, the longer the time spent in such a setting, the higher the resting glucocorticoid level. As seen in the review of literature, high glucocorticoid levels have negative impacts on memory and learning, thus being a possible contributing factor for what was found with this group of IA children.

Stress and micronutrient deficiency variables

Turning to in utero stressors and markers for micronutrient deficits, those born with LBW (again, a marker for stress and nutrient deficits) continued to have poorer general medical conditions and undernourishment years later. Additionally, their L1 was not age appropriate and their functional ESL skills, both comprehension and production, were more delayed. Children who were premature also continued to have poorer general medical health along with underweight status years later, but their language problems were not as great as those who had been LBW. This may be an artifact of the degree of low birth weight, that is, those of extreme small size for gestational age may be more negatively impacted (Wright, Thislethwaite, Elton, Wilkinson, & Forfar, 1983); alternatively, the degree of prematurity in this particular sample of children may have been relatively small. Finally, considerable alcohol use resulting in fetal alcohol syndrome resulted in continued poorer medical condition along with first language delays.

Moving to post birth markers for stress and nutrient deficits, general medical condition, undernourishment, underweight status, and anemia were all significantly correlated with each, a finding that, though expected, does present a picture of complex deleterious

processes that are on-going and lacking in resolution. All of the post birth stress/deficit markers were significantly correlated with a first language proficiency that was increasingly below age appropriate levels, a concern. All of the markers, except for anemia, were also significantly correlated with degree of problems in the ability to learn English across all four dimensions: both comprehension and production, in both functional and academic domains. Again, this supports the existing literature regarding the broad and long-lasting effects of stress and micronutrient deficits.

Language variables

In order to obtain a clearer image of the factors related to language, it would be better to look at these separately, rather than within the other variables. The first two dimensions of ESL comprising functional skills are correlated with the same stress/deficit variables: LBW and general medical condition, undernourishment, and underweight status years later. As expected, functional ESL is correlated with academic ESL. Looking at these academic language areas, it can be seen that once again, general medical condition, undernourishment, and underweight are significantly correlated, but not LBW. In reverse, learning academic English is correlated with learning functional English. The question arises, though, of why LBW is not a significant factor in academic English whereas it was in the learning of functional English. Since LBW impacts the acquisition of functional skills, and functional skills impact the acquisition of academic skills, there may be a masking effect occurring. Finally, all dimensions of ESL acquisition were significantly correlated with L1 proficiency, thus supporting the view that a first language provides support for the learning of a second (Cummins, 1992; Thonis, 1992). What, though, impacts the first language? This was the question posed – and left up in the air – by Pearson and Spoelhof (2006) with a smaller cohort of this same population pool. The above results now offer some explanations for factors that might explain poor L1 proficiency: early stressors such as LBW and later stressors such as

general medical condition, undernourishment, and underweight. With changes in the functioning of neurotransmitters in the brain that impact memory and learning, effects can be seen for language learning as well. In fact, with problems in language learning, all other learning will be compromised. Thus, language learning may be one of the key and first contributors that then causes a cascade of other learning problems to become evident.

Questions

Two questions were raised in this study. First, do markers of stress and micronutrient deficiency impact the ease or difficulty in learning English in this particular population of learners? Results indicate that yes, both early (in utero) and later stressors continue to exert a significant negative effect on the ability to learn ESL. The second question, more specific and not previously addressed by others, asks: what is the impact of stress and micronutrient deficiencies on the following ESL dimensions: 1) comprehension of functional English, 2) production of functional English, 3) comprehension of academic English, and 4) production of academic English? The answer is that these stressors negatively impact all four dimensions of second language learning, both functional and academic. No dimension of language appears to be immune to these stressors and deficits.

What, then, are the implications of these findings? Teachers cannot erase the stress that their students experienced in utero, nor many of the stressors their students and the students' families continue to experience. However, teachers can be proactive in securing appropriate assessment and intervention services in a timely manner. Because of the impact of first language proficiency on second language learning, all English language learners (ELLs) should ideally have their L1 proficiency assessed at time of school entrance. This is especially important for IA students who 1) are at high risk of language and learning problems, and 2) tend to "lose" their L1 quickly while at the same time the L2 may emerge slowly.

This problem of first language attrition in IA children has been discussed previously regarding whether the L1 is actually gone or whether the problem lies in accessing it (Pearson, 2012a, 2012b); it has also been discussed in a case study format (Pearson, 1997). This loss, though discussed in relation to IA children, holds for all second language learners: it is very difficult to determine delay vs. disorder, especially if the L1 has undergone stagnation or attrition with the introduction of the L2. Without an L1 baseline prior to the introduction of the L2, it may not be possible to determine whether the cause of the difficulty is a language processing problem or something else.

In addition to advocating for early assessment, teachers can also push for early intervention and support services due to the complexity of the situation with IA students (Pearson, 2005, 2010). Miller (2005) has noted that “disorders of relating and communicating” is [often] the most frustrating for parents, and the most difficult to treat” (207). For this reason, emphasis should initially be placed on the pragmatics of language, rather than a heavy focus on its structure (Pearson, 2011/2012). Again, this holds for all ELLs - parents need to be able to communicate with their children, and this includes in the L1 or language in which the parent is most proficient. But teachers and speech-language-pathologists must not be so focused on ESL vocabulary, morphology, and syntax that another element of communicating – pragmatics, the use of language – is overlooked. For the psychological health of all ELLs, the ability to communicate thoughts and feelings is paramount.

Conclusion

Recent brain imaging techniques showing the effects of stress and micronutrient deficits on memory and learning are bringing a new dimension to how teachers assess and work with learners. This study, using a unique population of ESL learner, that of IA children, offers support for studies done with the general human population. In fact, due to the degree of stress and deficits that IA children experience,

both pre- and post-natal, the impact is seen more clearly. Data from the IA children in this study show the complexity of variables that impact both functional and academic ESL, as well as their long-standing nature. Further, problems with learning ESL are at least in part impacted by problems in learning the L1. Teachers should be aware of the plethora of stressors that can impact all their students, especially their ELLs, and what this means for their long-term learning. It is further hoped that teachers of IA students, knowing the background of this unique population, will seek appropriate support services – earlier than later – for any students that are struggling.

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