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RESULTS FROM YEAR TWO OF A BRAIN DEVELOPMENT UNIT WITH PRESERVICE TEACHERS

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Abstract

An accurate understanding of brain development enhances teachers' understanding of how their students learn. Therefore, researchers collaborated to provide accurate information concerning brain development to preservice teachers. This study addresses neuromyths and general brain development misconceptions that were found to be persistent in a study conducted the previous year (Morrissey & Northcutt, 2023). Year two sample consisted of a different cohort of 12 teacher candidates than the year one cohort. Researchers addressed neuromyths and misconceptions with a unit on brain development that included inviting a neuroscientist into the preservice classroom to share accurate knowledge about brain development at different stages throughout K-12 schooling, with an emphasis on brain development knowledge on which the year one cohort scored low. In addition to assignments and activities from the previous year, pre-service teachers read an additional article about learning styles and read a collection of abstracts about the effects of sugar. Preservice teachers were given a pre-test, post-test, and end-of-semester test, and asked to journal about "What did you learn that surprised you? How will you use the information from today to understand students?" following the presentation by the neuroscientist. Data were analyzed to determine which neuromyths and misconceptions were persistent right after the brain development unit ended (during week 5 of a 16-week semester) and at the end of the semester. Because of the small sample size, data were analyzed qualitatively. Pre-, post- and end-of-semester-assessment results were compared. Responses to the discussion post were used to provide consistency and depth to results from the post-assessment (Krathwohl, 2009). Researchers saw improvements in areas that were emphasized more in year two. However, misconceptions continued to be apparent around whether the use of learning styles in the classroom were useful in improving student outcomes, and whether children must acquire a native language before learning a second language.

Keywords: *Educational psychology, teacher education, neuromyths, brain development.*

1. Introduction

Neuromyths, unscientific ideas about the brain (Crockard, 1996, as cited in Howard-Jones, 2014), can be distortions or misinterpretations of proven hypotheses reported in the media (Pasquinelli, 2012). Neuromyths appeal to the general public, including preservice teachers, because they reinforce intuitive beliefs and observations (Howard-Jones, 2014; Pasquinelli, 2012; Purdy & Morrison, 2009). However, an accurate understanding of brain development is especially important in education, due to the relationship of brain development to social economic status, as well as how an understanding of brain plasticity leads to a growth mindset (Coch, 2018). Without access to accurate brain development information, preservice teachers rely on their own ideas gleaned from various resources, which can be detrimental to their teaching practices (Howard-Jones et al., 2009). Sources of neuromyths have been found to be popular media (Beck, 2010; Carter et al., 2020; Tardif et al., 2015), general knowledge, academic staff, school staff (Carter et al., 2020), readings, and teacher training courses (Tardif et al., 2015). Previous researchers have recommended a strong connection between educators and neuroscience researchers as a way to improve brain development knowledge and understanding, thus improving the use of evidence-based practices in the classroom (Coch et al., 2009; Dubinsky et al., 2013).

Researchers have identified common neuromyths, such as left-brain versus right-brain dominance, we only use 10% of our brain, children must acquire their native language before learning a second language, critical periods exist for learning new material (Karakus et al., 2014; OECD, 2002; Pasquinelli, 2012), and the belief that teaching in a student's preferred learning style or intelligence

profile improves learning (McMahon et al., 2019; Willingham, 2004). Several studies in the recent past have documented the existence of neuromyths in preservice and inservice teachers. Howard-Jones et al. (2009) developed a survey to investigate the brain development and neuromyth knowledge of preservice teachers, and Dekker et al. (2012) devised an instrument to look for evidence of neuromyths and brain development knowledge in teachers. In both studies, researchers found beliefs that reflected popular neuromyths concerning the influence of environment and genetics on student success. Other researchers subsequently used either the instrument from Howard-Jones et al. or the instrument from Dekker et al. with similar findings (e.g., Deligiannidi & Howard-Jones, 2015; Dundar & Gunduz, 2016; Ferrero et al., 2016; Gleichgerrcht et al., 2015; Hughes et al., 2020; Karakus et al., 2014; Macdonald et al., 2017).

To alleviate neuromyths, Kowalski & Taylor (2009) included neuroeducation courses in a teacher education program that used refutational lecture and text, resulting in significant changes in the beliefs of teacher candidates. Other treatments resulting in a decline in neuromyths include explicitly addressing neuromyths using a conceptual change model to create cognitive conflict (Grospietsch & Mayer, 2018), research-based innovations embedded in a teacher training program (McMahon et al., 2019), and addressing neuromyths in an educational psychology course during initial teacher training (Im et al., 2018). Overall, studies have shown that collaborations and interdisciplinary communication between science and education can reduce misconceptions, lead to meaningful, productive theories and result in more efficient teaching and learning strategies (Dekker et al., 2012; Hughes et al., 2020; Pasquinelli, 2012; Pickering & Howard-Jones, 2007; Sigman et al., 2014).

To address the prevalence of neuromyths and lack of knowledge of brain development in preservice teachers, researchers in this study collaborated to provide a neuroscience unit to preservice teachers. Researchers asked the questions, What neuromyths are present in second-year preservice teachers, and are any of the neuromyths present able to be alleviated by the neuroscience unit short-term and long-term? Which neuromyths are more resilient? This paper reports on year two of the study, during which researchers targeted neuromyths and brain development misunderstandings that were seen to be persistent at the end of year one (see Morrissey & Northcutt, 2023).

2. Methods

The year two sample consisted of 12 secondary preservice teachers in their second year of undergraduate teacher education, enrolled in an adolescent psychology course as part of their teacher certification program. Teacher candidates were seven White females, one Indian female, three White males and one Black male who planned to teach middle or high school music, Spanish, mathematics, history or language arts. The pre-, post-, and end-of-semester survey of 20 general assertions about the brain and ten neuromyths was developed from the instruments used by Howard-Jones et al. (2009) and Dekker et al. (2012), with additions from Kim and Sankey (2018) and Blanchette Sarrasin et al. (2019), and changes to wording of some questions recommended by Macdonald et al. (2017). Responses allowed were Agree, Disagree, or Don't Know. At the end of year one, the post-survey had indicated persistent neuromyths were the belief that children are less attentive after consuming sugary drinks and/or snacks, and the belief that children must acquire their native language before a second language is learned. The most notable general brain development knowledge misunderstanding was that boys' brains are the same size as girls brains. Confusion was evidenced over whether learning styles were shown by research to impact learning. For year two, these beliefs received additional attention.

Researchers collaborated on a unit on brain development that included inviting one of the researchers, a neuroscientist, into the preservice teacher education classroom to share accurate knowledge about brain development. A video on brain development (Blakemore, 2012), two articles (Howard-Jones, 2014; Schultz, 2009), and relevant textbook chapters (Durwin & Reese-Weber, 2018) were part of the unit. The article by Schultz addressed, among other neuromyths, the neuromyth that children must acquire their native language before a second language is learned, which was also mentioned by the neuroscientist. To address the persistent neuromyth that children are less attentive after consuming sugary drinks and/or snacks, an additional assigned reading consisted of a collection of abstracts from three articles that addressed the effects of sugar on children's behavior (Rosén et al., 1998; White & Wolraich, 1995; Wolraich et al., 1995). In addition, this neuromyth was emphasized in the lecture by the neuroscientist. The neuroscientist's lecture also emphasized brain size, sharing data on the size of boys' brains versus girls' brains. Teacher candidates read an article addressing learning styles, their misconceptions, and use in the classroom (Papadatou-Pastou et al., 2021) to attempt to clearly define the role of learning styles in the classroom.

Preservice teachers were given the survey as a pre-test, post-test, and end-of-semester test. In addition, preservice teachers were asked to journal about "What did you learn that surprised you? How will you use the information from today to understand students?" following the presentation by the

neuroscientist. Pre-, post- and end-of-semester-assessment results were compared to determine to what degree neuromyths were eliminated right after the brain development unit ended (during week 5 of a 16-week semester) and at the end of the semester. Responses to the discussion post were used to provide consistency and depth to results from the post-assessment (Krathwohl, 2009).

3. Findings

Table 1 shows the results of pre- post- and end-of-semester assessment for neuromyths and the one brain knowledge question that was emphasized in the brain development unit. Items of note on the end-of-semester results include improvements in two areas of focus, the effects of sugary snacks and the size of boys' and girls' brains. However, the third area of focus, acquisition of a native language, continued to be persistent, as did the fourth area of focus, "Individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual, kinesthetic)".

Three other neuromyths showed improvements, namely "We only use 10% of our brain", "Some of us are 'left-brained' and some are 'right-brained' and this helps explains differences in how we learn" and "There are critical periods in childhood after which certain things can no longer be learned". Two neuromyths, concerning drinking caffeine and extended rehearsal of mental processes, were marked correctly by at least 50% of teacher candidates on the pre-test, and showed improvements on the end-of-semester test. One neuromyth was not alleviated to the same extent in year two as year one. At the end of the semester, 50% of teacher candidates agreed with the neuromyth "Learning problems associated with developmental differences in the brain function cannot be remediated by education."

Four preservice teachers mentioned content related to the four focus areas when they wrote their reflections after the neuroscience lecture, stating that they learned that male brains are actually larger on average than female brains. Those four teacher candidates each answered the question about brain size incorrectly on the pre-test, and correctly on the post-test.

Table 1. Assessment Results Year Two.

Brain development knowledge (T true or F false)	Percent correct pre-test	Percent correct post-test	Percent correct end-of-semester
Boys have bigger brains than girls (T)	8.3	83.3	83.3
Neuromyth (T true or F false)			
Children must acquire their native language before a second language is learned. If they do not do so neither language will be fully acquired (F)	58.3	75	58.3
We only use 10% of our brain (F)	33.3	91.7	91.7
Some of us are "left-brained" and some are "right-brained" and this helps explains differences in how we learn (F)	33.3	75	83.3
There are critical periods in childhood after which certain things can no longer be learned (F)	41.7	66.7	83.3
Individuals learn better when they receive information in their preferred learning style (e.g. auditory, visual, kinesthetic) (F)	8.3	75	50
Children are less attentive after consuming sugary drinks and/or snacks (F)	8.3	75	75
Regular drinking of caffeinated drinks reduces alertness (T)	58.3	83.3	83.3
Extended rehearsal of some mental processes can change the shape and structure of some parts of the brain (T)	58.3	58.3	75
Individual learners show preferences for the mode in which they receive information (e.g. visual, auditory, kinesthetic) (T)	75	58.3	66.7
Learning problems associated with developmental differences in the brain function cannot be remediated by education (F)	41.7	58.3	50

4. Discussion

Persistent neuromyths for year two were the belief that "Children must acquire their native language before a second language is learned ...", and "Learning problems associated with developmental differences in brain function cannot be remedied by education." The myth about language acquisition was addressed in the neuroscientist's lecture, although minimally. It was also addressed in the reading by Schultz (2009). Belief in this myth varied widely in previous studies (e.g., Dekker et al., 2012; Dundar

& Gunduz, 2016; Ferrero et al., 2016; Karakus et al., 2014; Macdonald et al., 2017). More investigation is needed to determine why this myth is so persistent. Belief in the learnings problems myth is unfortunate, as this is an important concept related to a teacher's effectiveness in teaching those students with learning problems (Howard-Jones, 2014). This neuromyth was addressed solely in one article (Howard-Jones, 2014). Researchers plan to address this myth directly and completely in the following years.

Still problematic in year two was the distinction between individuals preferring to learn in a particular style and individuals learning better when they received information in a particular style. This topic was addressed in the textbook (Durwin & Reese-Weber, 2018) and in the Howard-Jones (2014) article. In year two, teacher candidates also read an article specifically targeting the learning styles myth (Papadatou-Pastou et al., 2021). Lacking was specific discussion of this topic during the lecture by the neuroscientist, pointing to a direction to take for the next year.

The belief that children are less attentive after consuming sugary drinks and/or snacks was addressed in the Howard-Jones (2014) reading, and in year two was additionally addressed with a collection of abstracts (Rosén et al., 1998; White & Wolraich, 1995; Wolraich et al., 1995) and related discussion, and explicitly in the lecture by the neuroscientist. Researchers found an improvement in understanding of this neuromyth, believed to be related to the additional resources and lecture discussion provided in year two. Improvement was also seen in the brain development knowledge question that "Boys have bigger brains than girls", which was emphasized and discussed during the lecture by the neuroscientist. Other neuromyths that were mentioned in the neuroscientist's lecture and mostly alleviated include the myth we only use 10% of our brain, some of us are left-brained and some are right-brained, there are critical periods in childhood after which certain things can no longer be learned, regular drinking of caffeine reduces alertness (true), and extended rehearsal changes the brain (true),

Findings of this study support the use of multiple sources of accurate brain development knowledge, and cement the belief that providing expert information directly from a neuroscientist benefits teacher candidates by lessening their belief in neuromyths and improving their brain development knowledge. Inclusion of neuroscience information has been found to be beneficial in several studies (e.g. Im et al., 2018; McMahon et al., 2019; Tadielo et al., 2022), reinforcing the finding that the presence of a neuroscientist as guest lecturer in the classroom adds legitimacy and substance to the information.

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