Patterns of Concentration in Montessori Preschools:

Investigating Concentration When Children Are Free to Choose Their Own Work

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Abstract

One key characteristic of Montessori classrooms is that children freely choose to engage with whatever they are most interested in. A common concern about Montessori is thus whether students will concentrate on their work throughout the day, and even whether they will actually choose to work at all. We completed 115 observations of children in Montessori Primary classrooms (ages 3-6), coding for children's concentration and activity across two to three hours in the morning. The best fitting model of concentration across time was a quartic model, including age. This model indicated that 3-year-olds had two bouts of concentration, with a brief period of fatigue mid-morning. Four-year-olds showed an increased ability to concentrate across the entire morning, with minimal indication of fatigue. Five-year-olds showed a higher level of concentration than their younger peers, and were able to concentrate longer than the 3-year-olds, but this was followed by a period of fatigue. These findings are in line with Montessori theory, and suggest that children do freely choose to concentrate on their work. In regard to activities that children chose to do, we found children choose to spend a majority of the time engaged in work. Further, children distributed their time across all areas of the classroom, indicating that choice does not limit their exposure to any one area of learning.

Keywords: Montessori, concentration, education, preschool, class activity

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Concentration is the act of cognitively attending to an activity to the exclusion of other factors and generally implies doing so for a prolonged period of time. Concentration is highly valued in modern US culture. Employees are required to concentrate on their jobs for hours at a time, preferably eight hours straight with minimal lunch break. High school students are asked to sit for hours concentrating deeply on high stakes exams. First grade students are asked to learn to sit through an entire school day while concentrating on lessons. In most cultural institutions, individuals are expected to know how to concentrate. Yet little to no lessons are presented to teach the skills necessary for deep concentration and little research has looked at how young children learn to concentrate.

Concentration at younger ages is often ignored; it is assumed that children under the age of 6 shift attention too much to be able to concentrate over longer periods of time (e.g. Harris O'Hanlon, 2013). Despite children being seen as having immature concentration, constructivists like Jean Piaget describe children with terms that imply the ability to deeply concentrate, such as by describing them as little scientists (Gopnik, 1996; Piaget, 1953). Stories passed down about well-known scientists often describe their concentration as so deep that it influences not just their work, but their daily routine; Sir Isaac Newton became so absorbed in his research that he forgot to eat (Montessori, 1918/1991, p. 125), and Albert Einstein reportedly wore a similar outfit every day to free his mind to solve problems of physics (Bell, 2019). Maria Montessori, like Piaget, was a constructivist, and went a step further with comparing children to scientists, directly equating the deep concentration she observed in both groups (Montessori, 1918/1991, p. 125).

Montessori believed that children do have the ability to concentrate deeply and believed that they could be taught the ability to concentrate for longer periods of time by being allowed to have free choice. In this paper, we will explore young children's concentration in Montessori classrooms across the morning during a typical school day. Montessori education was developed by Maria Montessori in the early 1900s. She was trained in medicine and worked with mentally ill patients. She was interested in how scientific principles could be applied to educating a boarder population, not just individuals with mental illness. To apply these principles to a broader population, she carefully observed what children were doing in the classrooms she oversaw and requested that teachers make adjustments to classrooms according to her observations. For example, the first classroom she worked with kept all materials in locked cabinets. However, one day the instructor forgot to lock the cabinet and the children who arrived before the instructor the next day got out the materials and began working on their own. This observation led Montessori to have teachers leave materials out in the open, freely accessible to children (Montessori, 1966, p. 121). Through this process of observing and responsively adjusting aspects of the classroom, Montessori developed her own education system throughout her lifetime. The Montessori education system is now widely used across the globe (American Montessori Society, 2019).

Montessori's anecdote of the locked cabinet is one of many in which she observed children who were given free choice independently selecting and concentrating on work. Her careful observations of concentration formed the foundation for her belief that free choice was important for teaching children to prolong concentration. However, within an academic context, this free choice also comes with the concern that children will choose not to do academic work. In this paper, we will thus explore what activities children freely choose to engage with in

addition to the main objective of exploring what concentration looks like across a typical morning in Montessori classrooms.

Choice and Concentration

Choice forms the basis of teaching prolonged concentration in Montessori classrooms. When given free choice, Montessori reported seeing children exhibit specific patterns of concentration across a normal day (see Figure 1). Students engaged with a material for about an hour, then showed signs of fatigue, but would reengage with more complex material and reach a deeper level of concentration later in the morning (Montessori, 1918/1991, p. 77). As children in her classrooms became accustomed to having free choice and concentrating deeply on work, they exhibited less mid-morning fatigue (Montessori, 1918/1991, p. 81). Once children had learned to concentrate steadily throughout the morning, their ability to concentrate more deeply continued to increase, raising the level of concentration they were able to maintain. Practice engaging for longer periods of time would suggest that Montessori students have high executive functions, that is a better ability to cognitively regulate their thoughts and attention, and indeed, research suggests they do (Lillard et al., 2017).

Montessori asked instructors to give children free choice for many reasons. One reason, as already mentioned, is that children in the classrooms she observed demonstrated the ability to choose to do work for themselves. Another reason is that she observed that children who were given free choice over what to work with demonstrated deeper concentration than their peers (Montessori, 1949/2010, pp. 186-187). Selective attention, the act of attending to an activity to the exclusion of others, is very similar to concentration, and research on selective attention shows it facilitates learning (Nissen & Bullemer, 1987; Rueda, Checa, & Rothbart, 2010). Thus, an emphasis on deepening concentration has the potential to also facilitate learning, further

supporting Montessori's emphasis on concentration as an important factor in education. In this paper we use the term concentration rather than selective attention to indicate its potential prolonged nature; in addition, selective attention is usually measured using visual attention (Driver, 2001), whereas the indicators we are interested in within a classroom context extend beyond vision.

Since choice is so important to Montessori's theory of how children learn to concentrate, to study her theory, it is best to study the development of prolonged concentration in environments where children consistently have free choice. The most effective way to do this is through naturalistic observations, where children are not forced out of their daily routine, making Montessori classrooms an ideal place to study this construct.

Benefits of choice for concentration. A variety of research supports that free choice is important for concentration. Free choice has the immediate benefit of increasing interest and the long-term benefit of supporting continued engagement with work, both of which influence willingness to concentrate over longer periods of time. Free choice also has potential benefits for maximizing working memory capacity, allowing for deeper concentration to occur.

Immediate benefits of choice. Choice provides immediate motivational benefits through increased interest. When students have free choice in their work, this gives them the freedom to do whatever work out of the available options is most interesting. Thus, simply providing choice means the activities students do will likely be more interesting to them than activities that someone else chooses. Further, even the act of choosing can increase interest in whatever choice is made (Zuckerman, Porac, Lathin, & Deci, 1978). In a study with adults, participants were given the simple choice between comparable puzzles with different images on them. Participants were asked to work on the puzzle for 30 min, then were left alone in the room. During this time

alone in the room, the experimenters assessed how long the participants chose to continue to engage with the puzzle. Participants who had originally been given the choice of what puzzle to work with engaged with the puzzle for longer than those who had not been given the choice. This simple choice alone made the activity more interesting and made participants more interested in continuing to engage. Through this mechanism, even if students choose something that is not as interesting as it could be, the simple act of choosing can increase interest.

The opposite relation between choice and interest is also true: lack of choice can lead to disinterest. One study with young children demonstrated that disinterest can form with as little as only one pairing between an activity and an indicator that there is a lack of choice to do that activity (Lepper, Greene, & Nisbett, 1973). Children in one study were observed drawing during normal class time to gauge interest in drawing, ensuring that all children had an established interest. Participants were then assigned to either a condition where they were told they could draw for a prize, were just asked if they would like to continue to draw, or were asked if they would like to continue to draw and were later given a prize after drawing. By telling some children to expected a prize, the researchers gave these children a reason to draw outside of just interest, giving an indication that the choice to draw was not completely the children's own. These children who expected the prize before drawing, and thus had reason to believe the choice to draw was not just their own, chose to spend less time drawing than the other two groups when observed in their classrooms two weeks later. These studies demonstrate that choice has the immediate benefit of prolonging engagement with work and limiting choice can decrease engagement over time.

Long-term benefits of choice. In addition to the proximal benefit of increasing engagement, choice has the longer term-benefit of increasing subjective wellbeing. Self-

determination theory specifies that psychological needs of autonomy, relatedness, and competence should be met to optimize subjective wellbeing (Ryan & Deci, 2000). The foundation of this theory is that when an individual's needs are met, she or he is able to focus completely on the potential joy an activity can bring about and not meeting personal needs. Free choice helps an activity meet all three of these needs.

First, the act of choosing is fundamentally self-determined and autonomous. Second, free choice allows individuals to work in community when desired. By working in community, the work gains meaning beyond simply the actions of the work. In more traditional didactic settings, children that have a stronger relationship with their instructor, that is have a stronger sense of relatedness, also have a greater sense of self-worth (Ryan & Grolnik, 1986). This greater self-worth suggesting these students feel increased meaning in their work. Third, choice allows children to choose activities that they feel competent doing, allowing students to self-select activities at an appropriate level for their learning. Research shows infants choose activities at the right level for their learning (Kidd, Piantadosi, & Aslin, 2012; McCall, Kennedy, & Appelbaum, 1977). Similarly, older children will also often choose to play with toys that allow them to learn something new (Schulz & Bonawitz, 2007). Whether or not children indeed choose to do activities that meet these three needs, free choice does provide the opportunity for them to be met.

In applying self-determination theory to academic settings, the recommendation from scholars is generally focused on increasing autonomy (Niemiec & Ryan, 2009), which increased choice fundamentally brings into the classroom. The benefit of meeting these needs is clear; individuals who have the three needs of self-determination theory met, do generally have a greater sense of wellbeing (Ryan & Deci, 2000). Further, individuals who have these needs met

are also more likely to continue to engage, suggesting stronger interest or commitment over time (Williams, Freedman, & Deci, 1998). In one study, patients were asked by doctors to continue self-treatment. Individuals who felt their needs were being more directly met were more likely to choose to continue self-treatment. Though this is not a classroom setting, the similarity of being able to choose something for self-improvement is similar.

As a school system that provides considerable choice, Montessori is very likely to help students meet the three needs outlined by self-determination theory. By meeting these needs, students are both more likely to have a greater sense of wellbeing and to continue to engage in their own academic work. Recent research looking at long-term outcomes of Montessori students shows they do have a greater sense of wellbeing, at least as adults (Vasc, Meyer, Fukuda, & Lillard, in preparation).

Potential benefits of choice for working memory. A third advantage of choice-based environments is that choice has potential benefits for working memory. Keeping working memory resources available is important for learning (Willingham, 2010). By having maximum working memory resources available, children have more capacity to manipulate and connect ideas.

The benefits of choice for working memory happen in a somewhat extended manner of making reinvestment processes salient, which decreases working memory resources. Reinvestment is a term used in psychology of motion research and describes a process in which an individual decides to reinvest, that is to change, her or his attention from one way of completing a goal to a new way of completing that goal (Buszard, Farro, Zhu, & Masters, 2013). When minimal progress is made towards a goal, the goal becomes more consciously salient, activating reinvestment processes (Dijksterhuis & Aarts, 2010). This process of increased

salience and activation of reinvestment processes is helpful when working towards a goal, as reinvestment can encourage new ways of completing the goal if something is not working well.

When paying attention to reinvestment, cognitive load is increased, thereby limiting working memory. When minimal progress is being made towards a goal, this reinvestment can potentially assist task completion and thus task performance. However, if reinvestment processes become salient during other tasks, this can limit task performance. In one study, adults were given a scale of rumination and perfectionism directly before doing an attention task (Desnoyers & Arpin-Cribbie, 2015). Both rumination and perfectionism indicate activation of reinvestment processes, either ruminating on goals unrelated to the current task, or on limited progress towards a very high goal for the current task. Both variables were found to be related to decreased performance on an attention task, supporting the idea that cognitive load was increased due to this extra processing.

Lack of choice creates a sense of learned helplessness, or at least a learned lack of choice, which is demotivating (Maier & Seligman, 1976; Rodin, 1976). The amotivation from having a lack of choice minimizes effort towards goals, causing reinvestment processes to take control, which in turn limits working memory resources. In this way, choice theoretically helps keep working memory capacity maximized, which in turn can help maximize learning and allow for sustained, deeper concentration.

Summary of the benefits of choice. Choice has the immediate benefit of increasing interest in an activity, even if that activity may not be the most exciting to the specific individual. This increased interest allows for and assists longer engagement with an activity. Choice has the long-term benefit of increasing a sense of wellbeing. It helps meet all three needs outlined in self-determination theory, and as these needs are met, individuals are more likely to continue to

engage with an activity. Finally, choice buffers against the learned helplessness that can come from not being able to make decisions. Where learned helplessness would in turn cause reinvestment processes to utilize working memory resources, choice minimizes the potential for this to happen. Free choice thus has many benefits for prolonging concentration and keeping working memory resources available for deeper concentration to occur. Over time, it is possible that these three benefits of choice would help children learn to concentrate for longer periods of time. However, it remains an open question whether young children do indeed concentrate for long periods of time in environments where they are given free choice.

Choice and Concentration in Educational Environments

One common concern for educational environments where children have considerable free choice is whether or not students actually remain on task. In a didactic classroom setting, teachers control what students pay attention to and how much time is spent on each activity, so teachers can more easily ensure children receive a well-rounded education, or at least are exposed to a well-rounded array of topics. In non-Montessori preschools, it is not that common to commit most of the day to academic content. One study found that pre-kindergarteners spent about a third of their time in teacher-led activities, many of which have an academic focus (Early et al., 2010). In the remaining time, children spent about a third in free activities and the final third in activities related to eating. Another study indicated that the balance of activity significantly changed going into kindergarten from pre-kindergarten, such that children spend more time in language (28 vs. 14% of the time) and math (11 vs. 6% of the time) activities and spend more time specifically working as opposed to spending time in free choice activities or not doing anything instructional (57 vs. 33% of the time; La Paro et al., 2009). This increased amount of work implies an increased push from instructors for children to do academic work. In

line with this, pre-kindergarteners spend more time than kindergarteners with no instructional activity (44 vs. 29% of the time) and in free choice activities (33 vs. 6% of the time). This study demonstrates that instructors increasingly put focus on showing children academic work. A different study of mixed-age preschools (children ages 2-6) focusing on science and math instruction, found about a quarter of instructional time is put towards science-related activities, and a quarter towards math-related activities (Piasta, Pelatti, & Miller, 2014). The fact that math and science shared an equal split of instructional time, rather than all of that time being only math or science, further shows that teachers are intentional in exposing children to a variety of academic topics.

Very little previous research has looked at whether or not students in Montessori classrooms choose to spend a comparable amount of time on academic work as their non-Montessori peers. One study did code for different activities in both Montessori and non-Montessori classrooms (Hojnoski et al., 2008). This study looked at the activities of snack, play, transition, pre-academic, fine motor activities, music, clean up, class business, story, self-care, and gross motor activities. The largest differences between Montessori and non-Montessori were play and pre-academic work, with Montessori children spending far less time playing (4 vs. 27% of the time) and far more time on pre-academic work (47 vs. 16% of the time). This study suggests that children in Montessori are spending a good amount of time on academic work. However, this study was limited by only looking at one Montessori classroom. It remains an important question whether or not Montessori students in a variety of schools, who spend the majority of their time in free-choice activities, are spending time in academic preparation.

Studying Concentration in Montessori Environments

Montessori classrooms are great places to study concentration for two reasons. First, they provide a unique setting where children have considerable free choice. Second, though Montessori gives numerous anecdotes of children concentrating, she rarely carefully describes her methods of synthesizing her observations nor provides any specific data (Montessori, 1918/1991). In passing on her teaching methods today, Montessori instructors are taught to be teacher-scientists, emulating Montessori's own research methods (Montessori, 1918/1991). Instructors are encouraged to look at and assess student concentration and make changes to their classrooms according to these assessments. While making changes, instructors try to always make sure children have choices available that they want to engage with and that allow them to practice concentrating. However, since Montessori's methods are unclear, most instructors simply take qualitative notes of student concentration, or sketch graphs of concentration with minimal quantitative backing (O'Shaughnessy, 2016). Further, since there are few metrics for comparing teachers' notes, most analysis happens on an informal and individual level and is not looked at systematically across classrooms. Thus, considerably more work must go into understanding Montessori's research methods and empirically looking at her theory, a process that would help provide instructors with scientific tools and measures to help them do observations within their own classrooms.

Using observational methods for research in Montessori classrooms today has several benefits. First, this is how Montessori developed her system, so using similar observational methods allows for the best understanding of how to work with schools in the same way she did. Second, since Montessori classroom instructors are explicitly encouraged to work with observational methods, it is already a part of the school ethos. Third, observational methods

allow for unobtrusive analysis of the classroom, allowing for studies that have greater external validity. This minimal intrusion is also important for allowing children to continue to be self-motivated, without external disruption. These three benefits are not just important individually, but also as a whole; better understanding Montessori's reasoning can help instructors, instructors' observations can help research, and research can help provide resources for instructors.

Present Study

In the present study, we investigated children's concentration throughout the morning in Montessori preschool classrooms. More specifically, we observed children during the time where they had free choice and examined whether children today follow a pattern of concentration similar to the one Montessori saw. The two main questions we addressed are: (1) What are the patterns of concentration that are occurring in Montessori classrooms today? Namely, are they the same as the patterns Montessori saw in her time? and (2) What activities do children in Montessori classrooms choose to participate in?

We addressed these two questions by doing unobtrusive observations and coding for both concentration and what activity each student was doing. Observational methods allowed children to continue to have the free choice that is so important for achieving deep concentration. We hypothesized that students would show a similar pattern of concentration to what Montessori observed. Namely, we hypothesize younger students would show a clear quartic pattern of concentration with a period of fatigue and older students would show a pattern of more steady concentration across the morning. Even though some of the materials students work with may have changed in the past 100 years, the development of concentration is likely similar. We

further hypothesized that students would choose to do work for a considerable amount of the time and would freely choose to do academic work.

Methods

Participating Classrooms

We observed 110 students (M = 4.5 yrs, SD = 0.8 yrs, range = 2.9-6.2 yrs; 54 female) in 10 different multi-age Montessori Primary classrooms. Classrooms were from six different Montessori schools (mean class size = 19.38, range = 17-24), all of which were private schools in suburban areas of the Southeastern and Midwestern US. Two schools continued through eighth grade; the other four only provided preschool. Class sizes varied from 14 to 24 students (M = 19.38, SD = 3.62). Each observation followed one child. Five children were inadvertently observed twice, but since these observations happened on different days and what children did from day to day differed greatly, these observations were counted as separate for the purposes of this study for a total of 115 observations. Observations took place during the morning work period, a period where children were given free choice to work on what they wished for about two hours to three hours. The morning work period usually started around 8:30-9:00 a.m. and ended around 11:00-11:30 a.m.. One observation was truncated by a large group activity that took place for a holiday (only 20 min of observation). However, some individual work time was present during that day, so this observation was included in analyses.

Observers

Observations were done by eight different observers. Observers were all extensively trained in the coding scheme using videos of preschool age children engaged in free choice activities. During training, each rating was discussed in detail and the first actual classroom observation for all but two observers were done with a previously-trained observer to allow for

discussion on reliability and follow-up questions after the first observation. If the two coders did not agree on some aspects of this first observation, training with the videos continued and another observation was done together before the observer did an individual observation. Before entering a classroom, all observers also had either previous experience working with Montessori schools or were taught the basic groundwork of Montessori pedagogy to provide context for the observations.

Observation Coding

During each observation, one child was observed. Observations began with 10 min of observation then the rater took a 5min break before doing another 10 min of observation and taking another 5 min break and so on. Coding was only done for activities that were freely chosen. Most classrooms began the day with students arriving and immediately starting individual work, so coding began at this point. For two classrooms, the morning consistently began with circle time, so for these classrooms coding began when the observed child left the circle and began independent work. The same criterion was used for the end of the day, with coding ending when the observed child either went to circle time or began preparing to leave. Children were generally allowed to move in and out of small group activities during the morning work period, so any group activity that happened during the morning work period was coded as freely chosen group activity.

For each minute of coding, observers noted three things: a rating of concentration, a broad assessment of what the child was doing, and an assessment of what academic area the child was working in (see Appendix for the coding sheet). For each minute, raters observed the child for 40 sec, then took 20 sec to code their observations before continuing. Each of these components is described next in greater detail.

Concentration scale. To rate concentration, we developed a seven-item scale based on ideas that Montessori noted as important for concentration and prolonged attention, as well as ideas from other researchers (e.g. Csikszentmihalyi, 1991). Each item was rated from one indicating not present or minimally present to three indicating almost always present to always present.

Three items ("oriented towards work," "touching material," and "looking at work") looked at physical orientation towards work for torso, hand, and eyes respectively. If the child exhibited the indicator for less than 10 sec, a one was given; if the child exhibited the indicator for the entire time or missing less than 10 sec, a three was given. The 10 sec of variable activity was included to account for instances like looking up from work when somebody walked by, a case where there is good reason to think concentration remains steady.

The next three items ("distracted by surroundings," "intentional actions," and "careful and slow actions") all looked at cognitive orientation towards work. "Distracted by surroundings" was rated in the same way as the physical orientation items, with the 10 sec rule for scores of one and three. For analyses, "distracted by surroundings" was reverse coded. The other two cognitive orientation items were rated as overall judgments of all actions that occurred during the observed minute. For example, if the child was reading a book for 20 sec and wandering the room for 20 sec, only the action of reading the book was coded. For "intentional actions," the emphasis was on whether or not the child's actions had a defined end goal. For example, scribbling has no set end, where coloring in a specific shape has a clear end and thus is more goal oriented and would receive a higher score. For "careful and slow actions," the emphasis was on taking time to do an activity methodically and striving for perfection.

The final item, was a global judgment of the student's concentration on a one to three scale. In final analyses, we used averages to smooth the data. Averages were calculated creating three average scores for each 30 min of observation such that the first 7 min of observation were averaged, then the remaining 3 min of a 10 min cycle and the first 3 min of the next cycle, and finally the remaining 7 min. The scale by itself showed good internal reliability, Cronbach's α= .93. A total of 24 children were also coded by two coders for reliability, and reliability was calculated using the averages used in later analyses, weighted κ = .78.

Type of activity. This code assessed what the child was doing for each observed minute and was intended to get a better understanding of how much time children were on task. These codes included working, getting a lesson, group activity, horsing around, waiting, snacking, observing other's work, wandering, and other (for any activities that did not fit these codes). A visit to the restroom was considered other. Many classrooms requested that children wash their hands first thing in the morning before beginning work. This routine hand washing was considered work. Group activity included lessons that were given to a group that children freely chose to be a part of. Since much of the work in Montessori Primary classrooms happens individually, we wanted to emphasize when children were working in groups. Thus, for times when lessons were being given to a group, the coded activity was considered group activity, though most activity that was group-oriented was child-directed, not teacher-directed.

Area of engagement. Whenever the child was doing individual work, we also coded what academic area the child was working in. Montessori classrooms are set up in clearly defined sections to help guide students to organize their understanding into broader topics. These sections are: sensorial, language, math, geography, science, practical life, and art. Not all instructors separate activities into these exact groups; for example, sometimes geography and

science are grouped together. However, for consistency in this study, we used these six areas. Sensorial is a category of the classroom filled with works designed to help students fine tune their senses. For example, color tablets are a collection of color swatches of varying hues that students need to put in order. The differences between colors is so fine-grained that they are notoriously difficult to order, even for instructors. Practical life activities are a staple in Montessori classrooms and include activities such as learning to button clothing and wash dishes. We also separated out grace and courtesy, which does not have a specific area of the classroom, but lessons in grace and courtesy are considered distinct in lesson planning. Though grace and courtesy lessons usually occur as a whole group during circle time, we observed some individuals doing work specific to grace and courtesy individually.

Results

Our main question was whether Montessori classrooms today follow the same pattern of concentration as Montessori noted in her work. The pattern described in Montessori's work is quartic, indicating a rise and fall of concentration with a false fatigue in the middle of the work period. If a similar pattern was followed without a period of false fatigue, the pattern would be quadratic. Consequently, the primary model we tested was a model describing concentration with time as a quartic variable. We additionally tested lower powers to see if simpler patterns across time might fit better, which might indicate a lack of false fatigue, or perhaps no warm-up or cool-down periods.

Our second question was what activities children choose to spend time doing in Montessori classrooms. For this analysis, we calculated percent splits of both type of activity and area of engagement. Each percent was calculated by tallying the total number of times each code occurred within every observation, dividing this by the total number of minutes observed, then

averaging across all observations. Averaging percent of time doing an activity across observations allowed the analysis to be minimally affected by varying class times.

Patterns of Concentration

Patterns of concentration were assessed using the lavaan package in R (Rosseel, 2012). Missingness was dealt with using full information maximum likelihood estimation. Observations were of differing lengths due to different schools having different amounts of individual work time. Although some observations did last three hours, this was an uncommon occurrence, meaning there was minimal data to estimate patterns of concentration late in the work period. Consequently, for patterns of analysis, we only used the first two hours of each observation, or the whole observation for those that were under two hours.

An initial analysis combined data across classrooms and age to see if there was a consistent quartic pattern. To test if a simpler pattern fit best, we started analysis with the intercept model, then added a power until reaching a quartic pattern. This analysis indicated that a quartic model fit best, see Table 1. The model fit using CFI and RMSEA are acceptable, though TLI is a bit low. Though this quartic pattern can account for a period of false fatigue and continued high concentration later in the work period, looking at Figure 2 (see Table 2 for beta estimates), suggests the children observed in this study do not really go back into deep concentration. The pattern instead suggests a period of deeper concentration at the start of the morning and a gradual decline in concentration as the morning continues, the quartic power of this model helping account for how gradual this decline is. The variances for the beta estimates were all significant (*p*-values ranging from .002-.004), suggesting there is between person differences still unaccounted for in this model. We next incorporated age into the model to see if this would describe some of the between person differences.

Incorporating age. For the intercept through cubic model, the addition of age did not improve the model, see Table 2. However, for the quartic model, the addition of age made a marked improvement for all three fit indices. Here the model fit is acceptable using all three fit indices, and all three show this was the best model we ran, consequently this is the model we retained. This model suggests that different ages have different variations on the overall quartic pattern. To investigate these age differences, we graphed both the model at different ages and compared this to the mean curve of the observed children, see Figures 3 and 4 (see Table 2 for beta and regression estimates). The model indicates that younger children show the most marked expression of false fatigue. Older children, around 4, exhibit less mid-morning fatigue and their pattern of concentration flattens. However, the oldest children instead show a deeper level of concentration earlier in the morning that grows for a longer period of time, but then again exhibit a clear decrease of concentration and fatigue later in the morning. The variances for the beta estimates were again significant in this model (*p*-values ranging from .003-.006), suggesting there are additional unaccounted for between person differences.

Activity Choice

Length of the work period did not influence calculations of percent of time doing various activities, so all observed minutes were used for these analyses. See Table 3 for the percent of time children spent in each type of activity. Children chose to do individual work about half the time. This was followed by group activity, which children chose to do about 10% of the time. It should be noted that in Montessori, children are often encouraged to do work independently when peers become distracting, so this lower percent is partially enforced by instructors. Only about 4% of available time was occupied by individual lessons. For a class of around 20

students, if students are getting equal attention, we would expect this average to be 5%, and so this number is close to expected.

Next, we looked at what areas of engagement children chose to work on independently; see Table 4. For this analysis, we used only the minutes that were coded as work. Children chose to do practical life activities for about 27% of the time, followed by art (18%) and language (17%). It is also interesting to note that children spent a larger percentage of time on language materials than math materials (8%). Children spent less than 1% of their individual work time doing grace and courtesy work, which is unsurprising, since this usually occurs during group lessons at circle time.

Across ages, the distribution of what areas of the classroom students engaged with remained largely consistent, though the exact percentage of time changed. There was a minimal decrease in practical life activities after age 3, and a decrease in geography and science activities at age 5. There was also an increase in language and math usage after age 3 and an increase in art at age 5.

Discussion

This study first sought to better understand if students' concentration in Montessori classrooms today follows similar patterns to those Montessori wrote about 100 years ago. Investigating these patterns allows for a better understanding of concentration within a Montessori classroom and Montessori's methodologies of observation, as she does not include much quantitative evidence within her own writing. Second, we sought to investigate what activities children choose in Montessori classrooms. A common concern when giving children considerable free choice in their academic activities is that children will not choose to do work, so we also sought to address this question within a Montessori context.

Patterns of Concentration

We first looked at patterns of concentration across the first two hours of the morning work period. We assessed patterns of concentration using powers up to Montessori's quartic model, where children demonstrated a period of warming up before concentrating for about an hour, then become fatigued before being able to continue concentrating for another hour and ending the morning with decreased concentration to lunch (Montessori, 1918/1991, p. 77). When all children were run in the same model, we found a quartic model does indeed fit the data best. In contrast to Montessori's original model, our model indicated a period of concentration early in the morning then a gradual decrease in concentration until lunch, rather than a clear period of rest and continuing into more concentrated work. However, this model was not the same across all ages, and the 3-year-old children in our study did show the clear quartic pattern that Montessori describes, with a period of false fatigue and a period of continued concentration after, see Figure 4. This is supportive of Montessori's assertion that children most clearly demonstrate this pattern of concentration when first learning to concentrate in a free choice environment.

Montessori described that although this quartic pattern was what she first observed, as children develop and become accustomed to working independently, they are better able to concentrate over longer periods of time, without a period of fatigue mid-morning (Montessori, 1918/1991, p. 81). We found that 4-year-olds do indeed show this pattern, not demonstrating the clear period of false fatigue that 3-year-olds do, see Figure 3. Of particular interest though are the 5-year-olds, who do not show this pattern at all. Instead, 5-year-olds show an increase in concentration going into independent work that is prolonged for about an hour before showing fatigue going into lunch. It should be noted that there is a slight dip in concentration for the 5-year-olds before they enter this period of deeper concentration. Many classrooms had a

handwashing routine, where children were required to wash their hands before starting their own work. This slight dip could likely be due to these children focusing on handwashing, then taking time to settle down into doing independent work. In contrast, the younger children often spent time wandering before needing to be reminded to wash their hands, so this short period of concentrated work at the beginning of the work period is not present for them. It is thus unsurprising, though still noteworthy, that for the children in this study, older children seem to have higher levels of concentration when first entering the classroom.

The pattern of concentration for 5-year-old children is considerably higher than that of younger children. This suggests that 5-year-olds have learned how to prolong a lower level of concentration and are starting to work on reaching even deeper levels of concentration on their work. This is in contrast to Montessori's theory that would suggest children simply reach a level state of concentration and as they learn to reach deeper levels of concentration, the pattern remains the same, just at a higher level (Montessori, 1918/1991, p. 83). Our findings instead suggest that as children learn to concentrate more deeply, they again experience fatigue. This could be extrapolated to suggest that as individuals learn to concentrate at ever deeper levels, they need to relearn to prolong this new level of concentration, so again experience false fatigue. Future research should investigate older children in free choice environments to see if they demonstrate a similar depth of concentration as 5-year-old children, but for longer periods of time. Though this research would be challenging with the transition into first grade that is present in most schools. Future research should also investigate other between person variables that might affect concentration, as the variances on our beta estimates were significant, suggesting additional between person differences beyond age.

Our findings regarding patterns of concentration support the idea that children in Montessori are learning to sustain attention and reach deeper levels of concentration, perhaps through the process of freely choosing their own work. That these patterns of concentration are so similar to those Montessori saw 100 years ago indicates that concentration and the development of concentration in preschool years has not changed significantly, even with the drastic changes in technology and childcare in that same time (Michel, 2011). Further, the changes in concentration across different ages implicate the important role of choice in developing executive functions. The free choice present in Montessori classrooms is specifically designed to help children reach these patterns of deeper and prolonged concentration and the fact that we saw these manifested in classrooms supports that choice may play a role in this learning process. The present study does not have the measures available to truly tease apart if choice is what helps with these changes, but these connections do make theoretical sense.

Choice of Activities

In regard to the work that children chose to do, we found children do chose to spend the largest proportion of time doing work. In fact, the children in this study spent more time doing work than students in non-Montessori preschools from previous studies spend in teacher-led activities (Early et al., 2010). This is in line with previous studies that found children in Montessori spend more time in pre-academic work than their non-Montessori peers (Hojnoski et al., 2008). We also found the percentage of time children spent in lessons was consistent with children getting an equitable distribution of instructor attention. Some comparisons can be made with specific areas of the classroom and results from other studies (i.e., La Paro et al., 2009), though these should be viewed with caution as methods between our study and previous studies differed. Comparison between Montessori and non-Montessori suggest pre-kindergarteners (ages

3 and 4) spent a comparable amount of time on language activities (16 vs. 14% of the time), though kindergarteners (ages 5+) spent less time on language activities (17% vs. 28% of the time). Further, children spent a comparable amount of time in math activities for pre-kindergarten (7 vs. 6%) and kindergarten (8 vs. 11%) and science activities for both pre-kindergarten (7 vs. 7%) and kindergarten (3 vs. 3%). These imprecise comparisons further support that the free choice of Montessori does not minimize academic time. These comparisons do not include many areas of the classroom like geography or art. For a quick comparison in this regard, children in Montessori classrooms spent considerably more time doing practical life activities than children in non-Montessori classrooms spent working on activities specifically to help fine and gross motor movements in both pre-kindergarten (28 vs. 7%) and kindergarten (28 vs. 4%).

Within a Montessori context, we found that children spent the largest proportion of time doing practical life activities. This is unsurprising for two reasons. First, children of all ages are able to do practical life activities, whereas more complex works like division in the math area requires more learning before being able to fully engage with the material. Indeed, children of all ages spent a good proportion of their time doing practical life activities, whereas older children spent more time on math and language than younger children. Art can also be engaged with at any age, making it unsurprising that it is another commonly chosen area of activity. Second, practical life activities are often encouraged in Montessori as something children are likely interested in learning, having seen adults do these activities at home. Consequently, they are used as a way of teaching children to concentrate as they build up to more complex work, further making them common activities in the classroom.

It is interesting that children also spent a larger amount of time doing language activities relative to other areas. This indicates a slight encouragement to focus on language in Montessori classrooms. Though children in classrooms are free to choose whatever material they wish, instructors do choose what lessons to give, guiding student interest. Eight of the 10 classrooms observed do not have Montessori elementary programs in the same school, so most children in this study are likely going into non-Montessori schools for first grade. The expectation for most non-Montessori first grade children is that they have some basic understanding of reading and writing, but do not need as much of an understanding in math (e.g., Common Core State Standards Initiative, 2019a; 2019b). Thus, language may be emphasized in these classrooms to help prepare children for the schools they are most likely to attend later, as having a deeper knowledge of math would not be as helpful. Anecdotally, many children do find the beginning of elementary school math classes boring if they have done the higher-level materials available to them in Montessori.

Overall Findings

The present study replicated some of Montessori's early findings, both that children develop the ability to concentrate over longer periods of time when given free choice and that children do indeed choose to do their own work. These findings show some support for the importance of choice in developing skills for concentrating and importantly show that Montessori students are indeed learning this important skill. The classrooms used in this study had varied times for children to work in the morning and were in a wide variety of different locations from specially made school buildings, to repurposed home properties, to office buildings. In conjunction with Montessori's observations, this indicates a consistency to these

patterns of concentration and a consistency with which children learn to concentrate for longer periods of time.

Certain limitations to this study should be noted. This study was done on a small scale because the coding process was intensive and required that only one child be observed at a time. Thus, not all children from each classroom were able to be observed. Future studies should observe whole classrooms to get a better sense of all students within a class. Further, all classrooms were part of private institutions, limiting the socioeconomic range of participants. However, the study did incorporate several different classrooms, assisting its external validity despite this larger limitation.

This study was also limited in the assessment of concentration that was used. It took considerable training to get observers to an acceptable level of reliability and even with this, there was room for improvement. Additionally, with only seven items that were rated on a three-point scale, the variability if this scale is limited. We addressed this in the present study by averaging across several minutes, but this process reduced the data and did limit the detail of models we were able to run. Future research should continue to explore new ways of assessing concentration in naturalistic, classroom settings. The present measure of concentration breaks concentration down into a few component parts, but by no means covers all aspects of concentration. These parts do provide some grounding for future work in classroom settings, but additional components should also be considered and assessed to get a more complete picture of concentration in future research.

Conclusion

This study is one of the first to find support for Montessori's observations of children's concentration across time in free choice environments; namely, that children will freely choose

to concentrate for long periods of time. Although they exhibit fatigue after a time, they will reengage with work again at a similar level of concentration as before. Further, as children get older they are better able to concentrate for longer periods of time and learn to concentrate more deeply. This increased ability to concentrate with age is unsurprising, but still critical given the importance of concentration in modern US culture. Montessori theory would suggest that this learning takes place in part because of the free choice within the environment. Further research should investigate if this factor of choice indeed plays as important a role as Montessori would suggest. This study also indicates that the free choice provided in Montessori classrooms does not cause students to forego academic work, as students worked a comparable amount of time to their non-Montessori peers. These two findings combined provide unique evidence and support for Montessori's theory of education.

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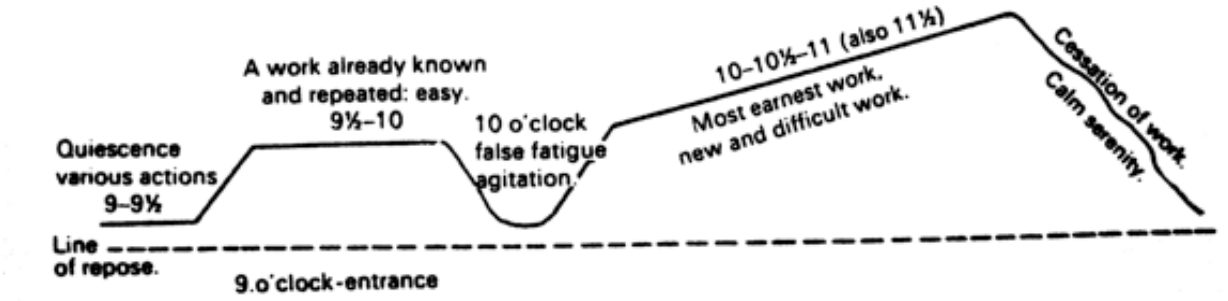

Figure 1. Montessori's graph of concentration throughout the morning work period (Montessori, 1918/1991, p. 77).

Table 1

Model Fit Statistics

	CFI	TLI	RMSEA
Intercept			
Time	0.702	0.741	0.092
Time + Age	0.696	0.727	0.089
Linear			
Time	0.755	0.778	0.085
Time + Age	0.740	0.756	0.084
Quadratic			
Time	0.819	0.827	0.075
Time + Age	0.799	0.799	0.076
Cubic			
Time	0.867	0.862	0.067
Time + Age	0.852	0.840	0.068
Quartic			
Time	0.911	0.898	0.058
Time + Age	0.920	0.903	0.053

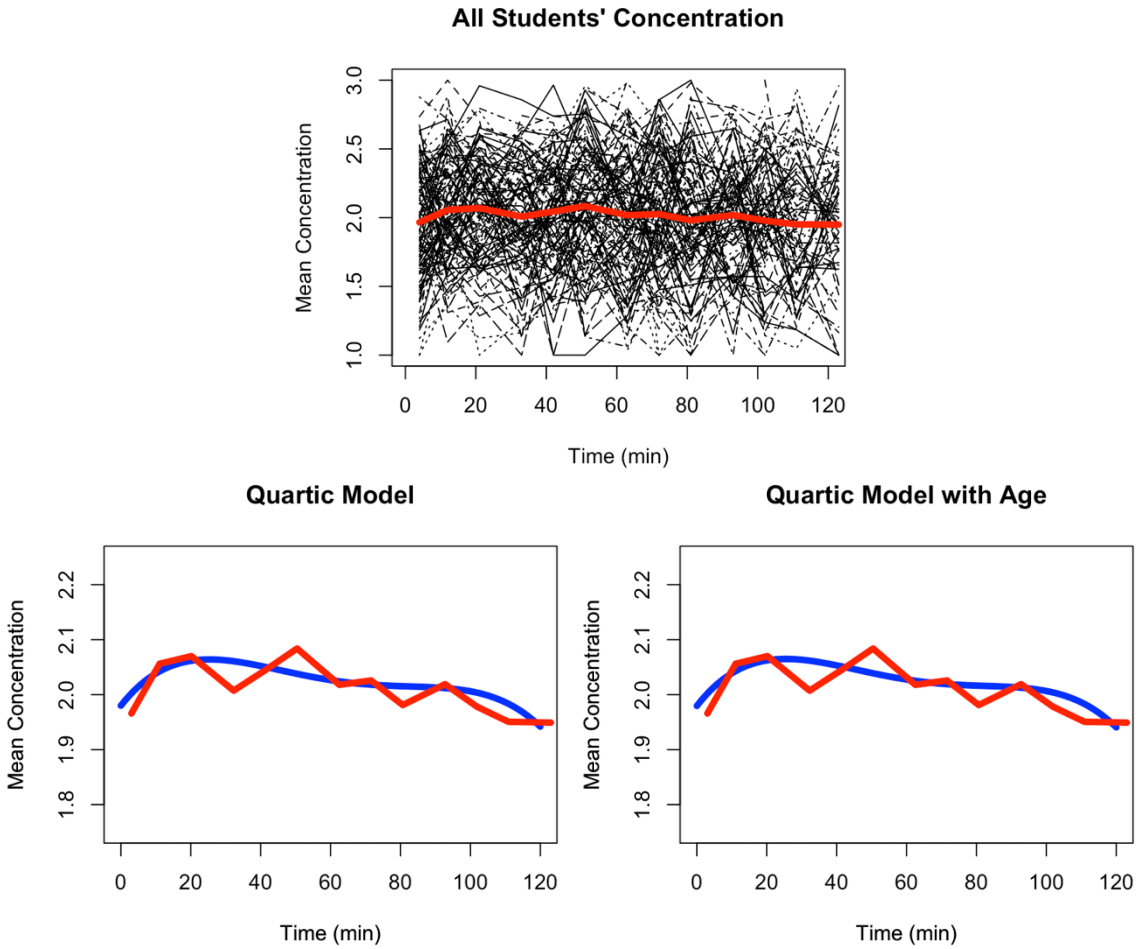

Figure 2. Students' concentration throughout the morning work period. The red line indicates mean concentration across students. The lower graphs show the mean in red with a smaller y-axis range to better see the shape of the curve. The blue line is the line indicated from the model. The lower left graph shows the quartic model with just time, the lower right shows the quartic model with age using the mean age of the entire group (4.46 yrs).

Table 2

Betas and Regressions for Quartic Models

	Quartic Model	Quartic Model With Age	
	Betas	Betas	Regression with Age
Intercept	1.980	1.342	0.143
Linear	0.976	8.216	-1.621
Quadratic	-3.698	-37.008	7.462
Cubic	5.044	54.662	-11.116
Quartic	-2.360	-25.267	5.131

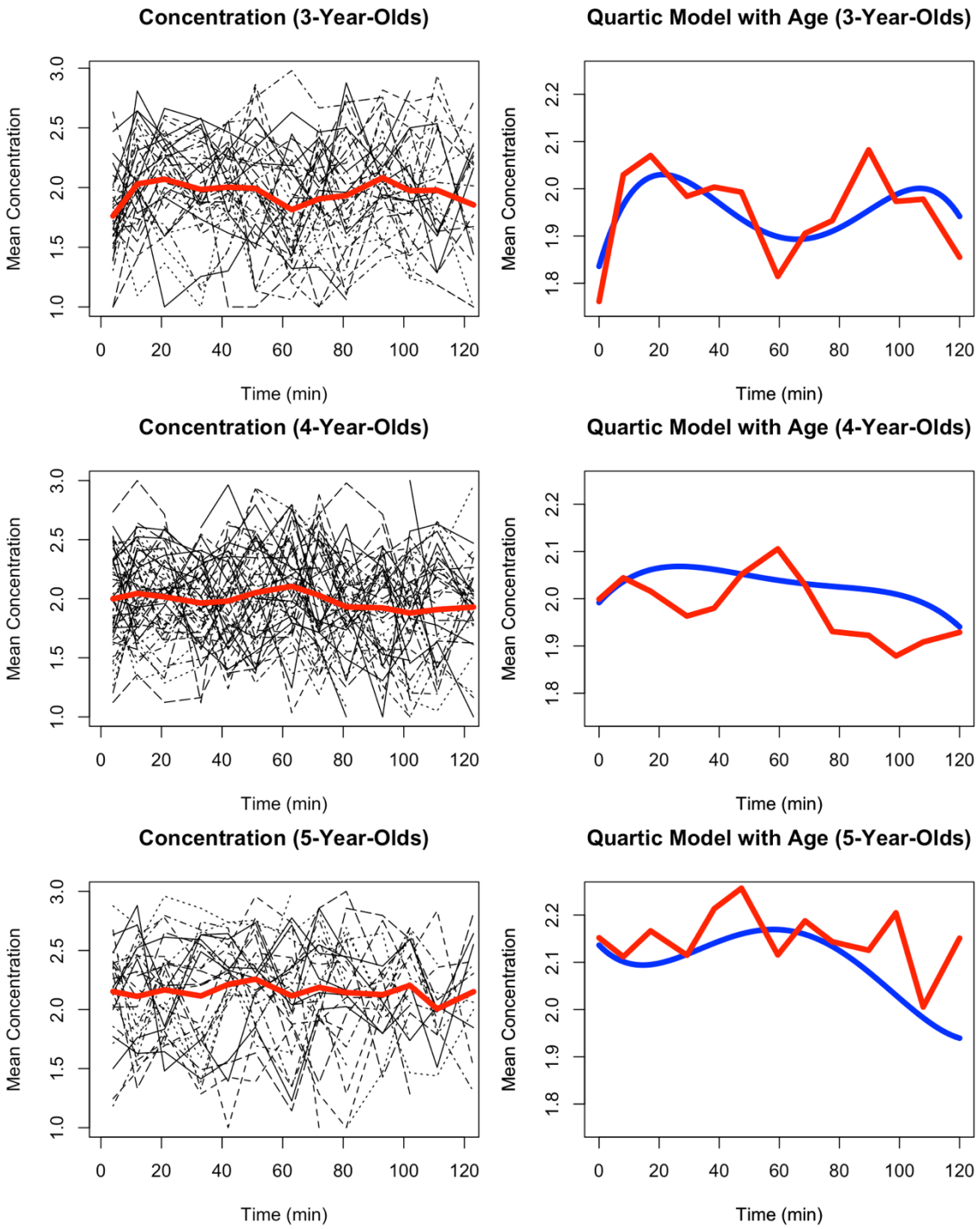

Figure 3. The top graphs show 3-year-olds' concentration (n = 39), the middle graphs 4-year-olds' concentration (n = 64), and the bottom 5-year-olds' concentration (n = 37). Since most 6-year-olds aged out of these classrooms, we did not have enough to create their own group; 6-year-olds were therefore grouped with 5-year-olds. The graphs on the right show the mean in red with a smaller y-axis range to better see the shape of the curve and the quartic model with age in blue. To calculate the model curve for each age group, the mean age of the group was used (3.45 yrs, 4.54 yrs, and 5.55 yrs respectively).

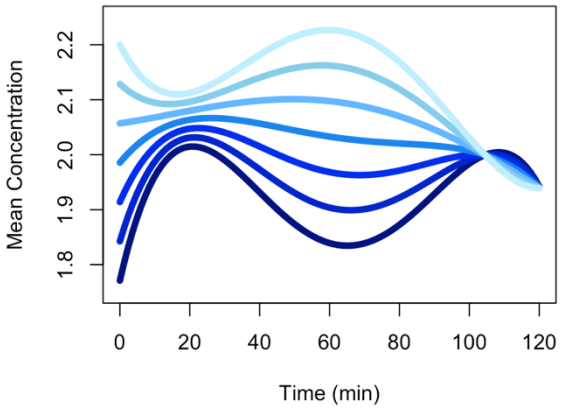

Figure 4. Quartic model of concentration with age. Each line shows the curve of the final model for different ages from 3-6 yrs going up by 0.5 yrs each time. Lighter blue indicates an older age.

Table 3

Percent of Time Per Activity

Age	Working	Getting Lesson	Group Activity	Horsing Around	Waiting	Snacking	Observing	Wondering	Other
All	50.1	4.00	11.9	2.0	2.9	6.2	5.9	12.4	1.7
3	48.0	4.2	4.5	2.9	1.6	7.9	9.9	15.8	2.0
4	47.2	4.4	13.9	2.4	4.0	5.5	5.2	11.7	1.7
5+	54.5	2.8	17.4	0.3	2.5	5.4	2.3	9.2	1.4

Note. All numbers are percentages.

Table 4

Percent of Activity Type During Individual Work

Age	Sensorial	Language	Math	Geography	Science	Practical Life	Art	Grace and Courtesy
All	14.8	17.2	7.5	8.4	5.6	27.2	17.9	0.1
3	14.3	11.3	3.8	10.3	8.8	34.2	16.4	0.0
4	16.0	21.0	9.6	10.0	4.8	22.8	16.0	0.0
5+	14.5	17.4	7.9	3.1	3.3	28.1	24.9	0.2

Note. All numbers are percentages.

Observer:_____Child ID: _____School: _____Date/Time: Sheet #: _____

Child Observation

Scoring: Rate each item from 1-3 (1 = not at all, 3 = completely)
Type of Engagement: Working (W), Getting Lesson (GL), Doing Group Activity (GA), Horsing Around (HA), Waiting (Wait), Snacking (S), Observing (Obs), Wandering (Wd), Other
Object of Engagement: Name material (Metal Insets, Silence, Song, -- if nothing)

	Oriented towards work	Looking at work	Touching material	Distracted by surroundings	Intentional actions	Careful actions	Concentration	Notes on affect	Object of Engagement	Type of Engagement
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Note if anything unusual happened since the last period.