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Examining Relationships Among Choice, Affect, and Engagement in Summer STEM Programs

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Abstract

Out-of-school time programs focused on science, technology, engineering and mathematics (STEM) have proliferated recently because they are seen as having potential to appeal to youth and enhance STEM interest. Although such programs are not mandatory, youth are not always involved in making the choice about their participation and it is unclear whether youth's involvement in the choice to attend impacts their program experiences. Using data collected from experience sampling, traditional surveys, and video recordings, we explore relationships among youth's choice to attend out-of-school time programs (measured through a pre-survey) and their experience of affect (i.e., youth experience sampling ratings of happiness and excitement) and engagement (i.e., youth experience sampling ratings of concentration and effort) during program activities. Data were collected from a racially and ethnically diverse sample of 10-16 year old youth (n = 203; 50% female) enrolled in nine different summer STEM programs targeting underserved youth. Multilevel analysis indicated that choice and affect are independently and positively associated with momentary engagement. Though choice to enroll was a significant predictor of momentary engagement, positive affective experiences during the program may compensate for any decrements to engagement associated with lack of choice. Together, these findings have implications for researchers, parents, and educators and administrators of out-of-school time programming.

Keywords: choice, affect, engagement, out-of-school time, STEM education

Introduction

Science, technology, engineering, and mathematics (STEM) occupations are predicted to continue to be high wage, high demand jobs and are projected to grow at a faster rate than non-STEM careers (Fayer, Lacey, & Watson, 2017). However, some evidence suggests a misalignment between youth interest and the current and future job market opportunities, as youth's interest in STEM areas tends to decline steadily throughout the middle and high school years (Brophy, 2008; Harackiewicz, Smith, & Prinski, 2016). Indeed, there is a shortage of workers in the United States with the competence and credentials to fill STEM jobs ranging from technicians to research scientists (National Academies of Sciences, Engineering, and Medicine, 2017).

Increasingly, out-of-school-time programs focused on STEM content—free from many of the constraints that exist in formal education systems—may have great potential for ameliorating interest declines during the middle school years (Mohr-Schroeder et al., 2014) and promoting interest in STEM careers (Dabney et al., 2012; Elam, Donham, & Solomon, 2012). Specific to STEM-focused summer programming, research has shown that adolescents' motivation and interest in STEM fields increased after they were involved in such programs (Greene, Lee, Constance, & Hynes, 2013; Mohr-Schroeder et al., 2014). Participation in out-of-school time STEM activities has also been associated with a higher likelihood of choosing STEM as a career interest while at a university and choosing a STEM career (Dabney et al., 2012). Youth who return to school after attending an out-of-school time program have seen improved work habits, task persistence, and peer interactions (Kataoka & Vandell, 2013).

Of course, the promise of out-of-school time programs for facilitating trajectories into the STEM workforce will be realized most fully if adolescents are completely *engaging* in the activities supported by these programs (Mohr-Schroeder et al., 2014). Engagement has been defined as a multidimensional construct containing components of effort and concentration and has been linked to dropout prevention (Fredricks, Blumenfeld, & Paris, 2004) and a variety of academic outcomes including academic achievement, persistence, and interest (Sinatra, Heddy, & Lombardi, 2015). Specific to out-of-school time programs, increased engagement may lead to additional learning opportunities and social competence, and it can transfer to high engagement and achievement in the classroom (Fredricks, 2011; Shernoff, 2010). Given the association between engagement and this wide range of positive outcomes and the promise of out-of-school time programs for building STEM interest and the STEM workforce, it is important to understand how to effectively engage youth in STEM experiences in the context of out-of-school time programs.

The degree to which one engages in a particular learning setting likely depends on both proximal and distal antecedents. For example, adolescents' immediate affective state (e.g., emotions comprised of happiness and excitement) in a given learning situation likely impacts their engagement. Pekrun and Linnenbrink-Garcia (2012) provide empirical evidence suggesting that positive affect is associated with higher engagement whereas negative affect is associated with engagement declines. One's engagement at a given moment may also be due to more distal factors like one's general level of interest in the learning domain and/or their reasons for being there in the first place. Because out-of-school time programs are not mandatory, youth may have the opportunity to exercise real choice in decisions about whether or not they participate in these programs. Allowing choice in learning is one way educators can support youth's autonomy (Patall, Cooper, & Robinson, 2008; Ryan & Deci, 2000), and youth who experience high levels of autonomy tend to demonstrate increased engagement (Fredricks et al., 2004). Much of the literature examining choice, however, has been conducted in formal learning contexts where students are given proximal choices (e.g., choose which of 3 worksheets to complete) within the structure of a broader activity (school) that students are required to attend. Little is known about whether engagement in non-mandatory learning environments like out-of-school time programs is influenced by whether or not youth were involved in the choice to enroll in the program in the first place, and whether such distal choices interact with adolescents' proximal experiences in the programs.

It is possible that adolescents' involvement in the distal choice to enroll in out-of-school time programs may have downstream consequences not only on their engagement in program tasks, but also on the degree to which their engagement is shaped by their proximal affective experiences in those programs (see Dijksterhuis, 2010). Youth who chose to attend an out-of-school time program may experience activities differently as compared to youth whose parent(s) sent them to the program, which in turn may affect their engagement. Thus, choice may have both direct and indirect effects. Alternatively, it is possible that youth's involvement in the decision to enroll (which occurs weeks if not months before the program begins) may have little bearing on how youth experience program activities because the choice is so temporally removed from these experiences. Adolescents' engagement patterns may be primarily explained by proximal factors such as their affective experiences during the program itself. It is unclear whether distal choices about out-of-school time program enrollment and proximal affective experiences have independent and/or interactive effects.

Understanding the complex relationships among choice, affect, and engagement is important because it can suggest whether choice and affect can play compensatory roles with respect to impacts on engagement in out-of-school time programs. Can positive affective experience in a program compensate for lack of choice about being there? Can choice compensate for a less-than-positive affective experience during program activities? These questions are the focus of the present study. Understanding these processes can inform out-of-school time STEM programs about where to focus their efforts (e.g., recruiting youth to participate, creating positive affective experiences at the program).

Out-of-School Time as a Context for Engagement in Early Adolescence

The term *out-of-school time programs* is used to refer to after-school or summer programs where school-age children focus on some form of activity in a voluntary learning environment (Lauer et al., 2006). Out-of-school time programs typically provide young students with mentors, aid employed parents by providing assistance with child care, allow youth to further develop their identity, and may provide an opportunity to pursue areas of particular interest (Hirsch Mekinda, & Stawicki, 2010). Out-of-school time programs focused on STEM may be particularly promising vehicles for enhancing engagement because they do not have the same time and curricular constraints as school environments (Renninger, 2007). Participants often have more control over how they spend their time in out-of-school time contexts, which may lead to deeper engagement and the development of interest (Falk & Storksdieck, 2005). As such, research has begun to examine how to make out-of-school time programs more engaging by examining the types of activities youth participate in during program hours. In out-of-school time contexts, youth tend to be less engaged when working on required homework activities (Shernoff & Vandell, 2007) and more engaged when working on hands-on activities such as design-oriented engineering projects, building 3D models of planets, and constructing robotics from LEGOs (Mohr-Schroeder et al., 2014; Yilmaz, Ren, Custer, & Coleman, 2010). Engagement also tends to be higher when youth believe that what they are learning will benefit them in the future (Greene et al., 2013) and when they are working with adults and peers who are caring and competent (Shernoff & Vandell, 2007). The current research adds to this growing body of research by examining the ways that choice and affect contribute to youth engagement in STEM-focused out-of-school time contexts.

It may be especially important to study engagement in out-of-school time programs during early adolescence, as this is a time where interest in STEM tends to decline (Brophy, 2008; Harackiewicz et al., 2016). Furthermore, autonomy development is important across most life stages for individuals, but is a central component during adolescence. Rapid increases in autonomous behavior typically occur during adolescence, and are seen as necessary for healthy development and the transition to adulthood (Dishion, Nelson, & Bullock, 2004). Adolescents develop an increased sense of self-direction as they take on more responsibilities at home and at school, as their social circles expand, and as their physical and cognitive abilities develop (Allen, Huaser, Bell, & O'Connor, 1994; Zimmer-Gembeck & Collins, 2003). Out-of-school time STEM programs have a potential to increase youth interest in STEM domains through engaging youth with experiences that will lead to positive affect; however, because these programs are optional, adolescents' involvement in the decision to enroll in out-of-school time STEM programs may impact their experiences while in attendance (Dijksterhuis, 2010).

Engagement

Engagement is widely considered a multidimensional construct that includes several subtypes (see Christenson, Reschly, & Wylie, 2012; Fredricks et al., 2004 for reviews). Drawing upon definitions used across a number of studies, we define behavioral engagement as one's level of participation and effort in social, academic, or extracurricular activities. Cognitive engagement refers to the mental investment one makes in learning (Fredricks et al., 2004; Sinatra et al., 2015). Although several models of engagement also specify an affective or emotional component to engagement (Sinatra et al., 2015), Pekrun and Linnenbrink-Garcia (2012) have framed affect as a precursor to other components of engagement, arguing that students' affective experiences while involved in academic tasks will affect their effort, concentration, and strategies for learning, whether or not they are aware of these effects. Thus, in the current study affective experiences are treated as an antecedent to the behavioral and cognitive dimensions of engagement.

In the present study, engagement is considered *in situ* or in-the-moment, and is assessed using the Experience Sampling Method, a signal-contingent method of gathering repeated reports of participants' immediate experience as it is happening (Hektner, Schmidt, & Csikszentmihalyi, 2007, see method section for more detail). As engagement tends to be highly variable across learning situations it is important to measure it at a relatively small grain size in relation to a particular moment in time (Shernoff & Schmidt, 2008). Capturing engagement close to when it happens may avoid recall bias typically observed with self-report measures (Sinatra et al., 2015). Understanding the momentary conditions and experiences that influence engagement at this grain size is likely to be of greatest use to educators, as they can exert a good amount of influence on these conditions and experiences through the design of their learning activities (Schmidt, Rosenberg, & Beymer, 2018). Observing engagement at this level is also consistent with literature suggesting that learning and development occur through processes that are proximal to the individual and lead to academic achievement as well as positive social interactions (Bronfenbrenner & Morris, 1998; Skinner & Pitzer, 2012). Thus, the current study focuses on youth's self-reports of the *behavioral* (i.e., effort), and *cognitive* (i.e., concentration) dimensions of their engagement across multiple time points as they are participating in various program activities such as lab activities, designing products, and watching presentations.

Choice as a Predictor of Proximal Processes

Many motivational theories suggest that providing choice is a way to increase students' perceptions of autonomy and control and is associated with adaptive academic outcomes (Pekrun, 2006; Ryan & Deci, 2000; Weiner, 1979) such as intrinsic motivation, task performance, effort, and perceived competence (Patall et al., 2008); however, researchers have also found choice to have negative or null effects on engagement and other learning outcomes (Flowerday & Schraw, 2003; Flowerday, Schraw, & Stevens, 2004). It is important to note that the conceptual framing underlying all of these studies, specifies that it is the act of having made a choice that is associated with adaptive outcomes (Ryan & Deci, 2000), rather than the individual's willingness or unwillingness to complete a given task. It is possible, for example, for a person to willingly complete a task about which (s)he had no choice. Motivation research has linked the perceived provision of choice to the outcomes listed above, among others (Patall et al., 2017; Patall, Vasquez, Steingut, Trimble, & Pituch, 2016). The act of making a choice, or the perceived provision of choice, is what is critical to these outcomes rather than one's willingness/unwillingness to complete a task they did not select for themselves.

Although research on choice in education has garnered much attention in recent years, much of the research has revolved around proximal decisions such as which assignment to choose (Patall, Cooper, & Wynn, 2010) and how long to study (Flowerday & Schraw, 2003). It is reasonable to assume that other types of choices (i.e., distal choices like should I spend my summer time in this program) may also impact proximal motivational processes such as affect and engagement. Distal choices, such as choosing a college and deciding on a college major have been examined (Galotti, 1995, 1999), but similar to research on proximal choices, this work has largely focused on undergraduate students and adults (Flowerday et al., 2004; Patall, 2013). Out-of-school time programs are typically optional for youth and decisions to enroll are usually made weeks or even months before the program begins; therefore, it is important to explore whether this distal choice does in fact impact proximal processes. Youth who chose to attend the program may experience program activities differently than youth who were signed up by a parent. Therefore, the decision to enroll may not only impact engagement directly, but may also impact the relationship between youth's affective experiences during the program and their engagement.

It has also been debated whether choice is truly the factor at play for increasing motivational outcomes or whether interest could be accounting for the benefits. It is possible that individual interest may drive youth's choices to some extent (Flowerday & Shell, 2015). For example, a student may choose to attend an out-of-school time STEM program because she is interested in science. Therefore, interest, not choice, may be the factor that is influencing proximal processes such as affect and engagement. Recent research has tried to identify the independent effects of interest and choice as predictors of learning and engagement. Flowerday and Shell (2015) have concluded that it is interest rather than choice that drives engagement based on their finding that interest had positive effects on engagement, whereas choice had no effect once interest was taken into account. In the current study, we control for adolescents' pre-program interest in STEM to isolate the unique effects of distal choice on youth engagement.

The Importance of Affect

Emotions and affect have not garnered as much attention in science learning contexts as other constructs including engagement (Fortus, 2014). This is surprising considering affect has been shown to be associated with student engagement (Reschly, Huebner, Appleton, & Antaramian, 2008). Furthermore, out-of-school time programs likely seek to create experiences that promote positive affect among youth. Affect, including specific emotions, has been examined as an important precursor to adaptive outcomes including engagement. Affect refers to one's general emotional tone as being positive or negative. In general, positive affect includes emotional states such as excitement, pride, and satisfaction and is positively associated with achievement and engagement. Negative affect refers to emotional states such as anger, anxiety, and frustration and is negatively associated with achievement and engagement (Pekrun & Linnenbrink-Garcia, 2012)[1].

According to control-value theory, appraisals of control and value, and emotions act as mediators between contextual factors (e.g., autonomy supportive environments) and engagement (Pekrun, 2006). It is possible that distal antecedents may impact engagement through youth appraisals. For example, youth's distal choice may impact appraisals of events (i.e. control-related appraisal) and affect (i.e. positive or negative emotional state), which in turn may mediate the relationship between environmental factors (i.e. instructional activities, expectations, cooperative learning) and engagement (Pekrun & Linnenbrink-Garcia, 2012). Considering that affective states tend to fluctuate (Linnenbrink, 2007), it is important to examine how youth's positive/negative affect may impact momentary engagement in out-of-school time STEM program as affect has been rarely examined in formal or informal science contexts (Fortus, 2014). Furthermore, it may be possible that youth's choice (or lack thereof) to enroll in out-of-school time STEM programs may contribute to the way youth's affective experiences relate to engagement.

The Present Study

This study explores choice as a distal process, momentary affect, and momentary engagement in a summer STEM program. Because out-of-school time programs are typically optional (Fredricks, 2011), it is important to understand the potential effects that choice may have on in-the-moment constructs such as engagement and affect. The research questions framing this study are: 1. What are the relationships among choice in the decision to register for the program, momentary affect, and momentary engagement in program activities (Research Question 1)? 2. Do choice and affect have interactive associations with youth's momentary engagement (Research Question 2)? Given the previous literature on choice and affect, we hypothesize that choice and positive affect, controlling for interest, will positively predict students' momentary engagement (Patall et al., 2010; Pekrun & Linnenbrink-Garcia, 2012). Further, we expect larger effects for affect than for choice, given the proximity of affective experience to engagement. Because of the exploratory nature of the question about the direction (i.e., positive or negative) of the interaction between choice and affect, no specific hypotheses were generated. The relationships to be examined are represented in Figure 1.

[1] There are complex theories of emotions such as control-value theory (Pekrun, 2006) and the circumplex model (Barrett & Russell, 1998; Linnenbrink-Garcia, Wormington, & Ranellucci, 2016) that discuss both the valence and activation of emotions; however, this study focuses solely on valence.

Figure 1

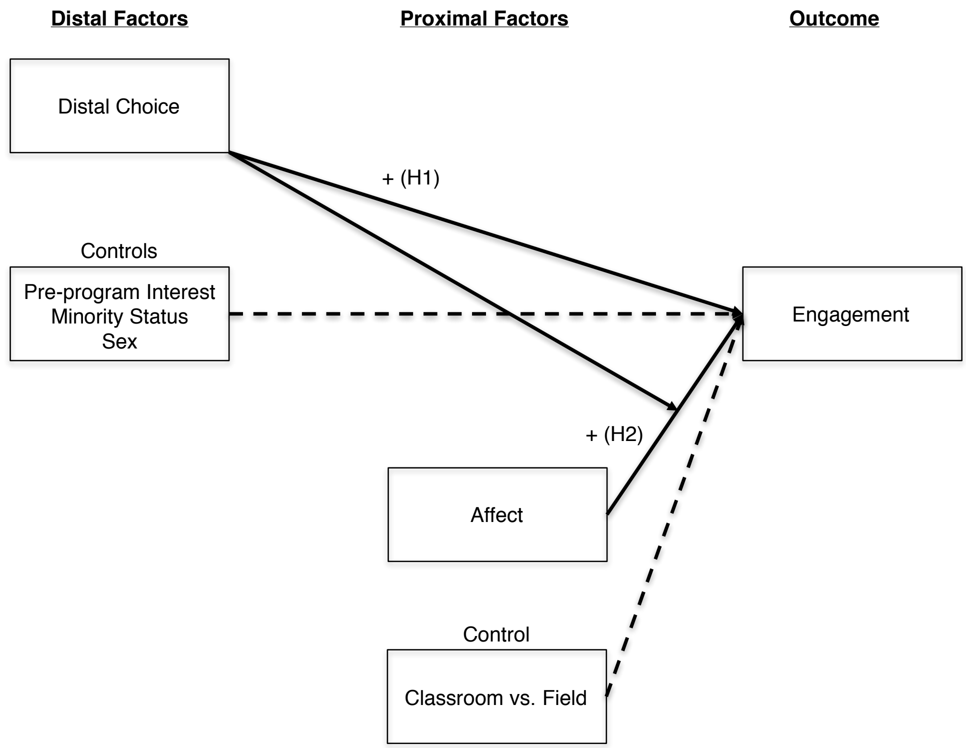

Figure 1. Conceptual model of relationships examined between predictor variables and engagement. Hypothesis 1 is denoted as H1 and hypothesis 2 is denoted as H2. The directionality of the hypotheses are denoted using +, to show that both hypotheses predicted positive associations. There is no hypothesis associated with the interaction between distal choice and affect on engagement, as this was an exploratory question. Dashed arrows are associated with control variables.

Method

Context

This particular study was part of a larger study that focused on the development of interest and engagement in summer STEM programs (Naftzger, Moroney, Schmidt, & Shumow, 2014). This study was carried out with nine summer STEM programs during the summer of 2015. These programs are part of two larger organizations in the northeastern United States that are committed to providing low-income youth with opportunities to participate in summer programs. The organizations are supported through funds from their associated public school districts and external granting agencies so that cost is not a barrier for youth. At each program, youth participate in a number of activities designed to foster interest in STEM areas. Each program focuses on unique content regarding science, math, engineering, or technology and on how these areas can be applied to youth's daily life. Most programs are designed so that youth spend about half of their time participating in field experiences with community partners engaging in activities such as building solar-powered go carts, designing computer games, exploring the ecology of islands, and planting community gardens. The remaining time is spent participating in classroom instruction focused on STEM concepts. The duration of each program was between four and six weeks, with youth participating for three hours on each of four days for each of the four weeks.

Participants

Data were collected from 203 adolescents (50% female). The demographic makeup was 6% White, 36% African American, 48% Hispanic, 7% Asian, and 3% multiracial (as presented in Table 1). The mean age of youth was 12.71 (*SD* = 1.18) and ranged from 10-16.

Table 1
Participant Demographic Characteristics

Students (*N* = 203)	% Students
Sex	
Male	50%
Female	50%
Race/Ethnicity	
Hispanic	48%
White	6%
Black	36%
Multi-racial	3%
Asian/Pacific Islander	7%
Age	
10	4%
11	28%
12	31%
13	21%
14	12%
15	3%
16	1%
Parent Education (*N*=171)	
High School or Below	79%
Graduated from College (B.A. or B.S.)	21%

Procedures and Measures

Prior to data collection, the study's principal investigators obtained approval to conduct the study from human subjects boards at their respective home institutions, from the administrators of participant programs, and from the larger organizational bodies that act as intermediaries for summer programs in the two cities where the research was conducted. A description of the study and optional consent forms were included with the registration materials parents had to complete in spring to register their child for the summer program. Student assent was obtained at the beginning of the camp session, prior to administration of the first survey. Across all programs, the study participation rate was 90%. Stipends were provided to participant programs to support the additional staff time required to launch the study. Youth participants were not given incentives for participation.

At the start of each program, youth first answered a survey in which information regarding individual interest, choice, and demographic information was collected. Within each program, data on adolescents' momentary affect and engagement were collected two days each week for three weeks (program weeks two-four). The data collection schedule was designed so that each week, data would be collected from each program during both field activities and during classroom activities. The mean attendance rate for the program was 83.08% (*SD* = 0.16) and ranged from 20% - 100% across students.

Experience Sampling Method. The experience sampling method is a method of data collection used to assess individual's real-time experiences by gathering repeated reports of subjective experience in response to signals emitted at random time points (see Hektner et al., 2007 for a description of the method). Youth were randomly signaled four times per day during six days of programming, with the condition that the signals must occur at least 15 minutes apart. In response to each signal, youth used mobile phones provided by the researchers to respond to multiple items measuring engagement (e.g., How well were you concentrating?) and affect (e.g., How HAPPY were you feeling), each on a 4-point Likert scale, from 1 (*not at all*) to 4 (*very much*). The result is a data set consisting of 2,968 total experience sampling method responses, for an average of 14.6 signals per adolescent (63% completion rate). Approximately half of the missing data is attributable to program absence (see attendance rates reported above). Once absence is taken into account, response rates were similar to many other experience sampling method studies of adolescents (Hektner et al., 2007). Because youth's choice to attend is a primary variable of interest, (see below for description of the choice indicator), we compared the average experience sampling method response rates for youth who chose to attend the program and youth who did not choose to attend using a t-test. There was a statistically significant difference in response rate for youth who chose to attend (M = .67, SD = .02) compared to those who did not choose (M = .59, SD = .03; t (121) = -2.06, p = .04); however, the magnitude of the differences in the means (mean difference = -.08, 95% CI: -.16 to 0) was small (d = .32), representing an average difference of about 2 signals over the 3-week period of data collection. We also compared whether average experience sampling method response rates differed by race and gender. There were no significant differences in response rate by race; however, a significant difference in response rate did exist by gender. Females average response rates (M = .66) were higher compared to males (M = .58, t (185) = 2.09, p = .04), but the effect size was small (d = .31). There also was no correlation between youth's pre-program interest and response rate.

We note here that short scales are generally acceptable when collecting experience sampling method data because many repeated measures are taken and multi-item scales are not feasible (Hektner et al., 2007). Previous research using the experience sampling method has used small-scale measures and found success (Shumow, Schmidt, & Zaleski, 2013; Strati, Schmidt, & Maier, 2017). Furthermore, Gogol et al. (2014) have examined reliabilities and validity between short-scales (1-3 items) and traditional long scales and found promising results suggesting the usefulness of short-scales.

Momentary engagement. A composite measure of momentary engagement was constructed by taking the mean of youth's ratings of *concentration* (i.e., How well were you concentrating?) and *effort* (i.e. How hard were you working?) at each experience sampling method signal. (α = .77). These items are task-specific and refer to the main activity that youth were participating in when they were signaled.

Affect. A composite measure of affect was constructed by taking the mean of youth's ratings of their *happiness* (i.e., How HAPPY were you feeling?) and *excitement* (i.e., How EXCITED were you feeling?) at the time of the experience sampling method signal (α = .86). We note here that this measure represents only positive affect. In preliminary analyses, we also explored the inclusion of a measure of negative affect (comprised of youth's ratings of frustration and stress) that was collected during experience sampling method signaling, but there was not sufficient variance in this measure to be useful in predictive models, thus only results for positive affect are presented here.

Distal choice. Youth were asked, "Whose idea was it to sign up for this summer program?" Three different response options were possible: (a) Student chose but somebody else (usually a parent) also chose; (b) Student chose and nobody else chose; (c) Student did not choose (the decision was made entirely by someone else). This item specifically focuses on how youth perceived their participation in the summer STEM program, rather than their willingness/unwillingness to be there, as motivation research has shown that it is the act of choice or the perceived provision of choice that leads to adaptive outcomes (Patall et al., 2008; Ryan & Deci, 2000). We also note that our measure of choice focuses on a very specific decision (i.e., the decision to attend a summer program). Therefore, our measure of choice is one item, whereas other measures focus more on "perceived" choice may be more likely to use multiple items.

Pre-program interest. A 4-point Likert scale, from 1 (*not at all true*) to 4 (*really true*), was used to assess interest (see Vandell, Warschauer, O'Cadiz, & Hall, 2008 for reliability and validity of this item). Youth rated their interest in science (i.e. I am interested in science.), math (i.e. I am interested in math.), and building (i.e. I am interested in building things.). Not every program focused on all aspects of STEM. For example, some programs only focused on math, whereas other programs focused on science and math. Because of this, survey items were specific to each program. Therefore, some youth reported on their interest in only one domain, while others reported on all three. In cases where youth rated their interest in multiple domains, the highest level of interest was used. That is, if an adolescent rated her interest in math a 3, but her interest in science a 2, she would have an overall STEM interest of 3. We chose this method rather than constructing a composite of all applicable domains by, for example taking the mean of multiple items because it is more straightforward methodologically to have the interest measure for all cases based on a single item rather than having a measure that was variously comprised by one, two or three items. Because one of our goals was to test whether individual STEM interest accounts for the effect of choice, choosing the higher of multiple interest provides the most conservative test of this. To test whether this measurement choice affected the results, in additional analyses (not shown here), we replicated the final models using a composite interest variable that was constructed by taking the mean of all available interest items, and results were comparable.

Video. Throughout the 6 days that experience sampling method data were collected, a videographer recorded classroom activities. The NVivo software was used to code the video data on several dimensions including location (classroom or field experience). Experience sampling method signals were also coded so that video data was able to be matched with student experience sampling method data to include in modeling. Inter-rater reliability was high (99%, K = .75). Location (classroom vs. field) was used as a control in the analyses since one's location might influence engagement.

Analytic Strategy

Following an initial descriptive analysis of all study variables, Hierarchical linear modeling was used for the primary analysis because the data are hierarchical with momentary observations nested within persons. Hierarchical linear modeling is well-suited to handle missing data and is ideal when the number of observations across participants differs (Raudenbush & Bryk, 2002). Level one variables consisted of momentary engagement (outcome), momentary affect, and location at the time of the experience sampling method signal (classroom or field experience). Level two predictors consisted of the decision to enroll (youth vs. other), and individual STEM interest. Because both race/ethnicity and gender frequently emerge as salient factors in students' STEM learning experiences and aspirations, these variables were also entered as level-two controls in the model, though they were not intended to be a central focus of the research. A model including a third level representing program was tested, but this more complex model was not warranted given the small amount of variance in engagement that was attributable to this level. All analyses control for adolescents' individual STEM interest, demographic information, and whether youth were in the classroom or participating in a field experience. To address research question 1 (What is the relationship among choice in the decision to register for the program, momentary affect, and momentary engagement in program activities?), Model 1 includes choice and affect independently as predictors of engagement. To address research question 2 (Do choice and affect have interactive associations with youth's momentary engagement?), Model 2 includes choice and affect as a cross-level interaction. Model equations are as follows:

Model 1:
Level 1: $Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Affect}) + \beta_{2j}(\text{Classroom}) + \varepsilon_{ij}$
Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Pre-Program Interest}) + \gamma_{02}(\text{Minority}) + \gamma_{03}(\text{Female}) + \gamma_{04}(\text{Choice}) + u_{0j}$
Mixed Model: $Y_{ij} = \gamma_{00} + \gamma_{01}(\text{Pre-Program Interest}) + \gamma_{02}(\text{Minority}) + \gamma_{03}(\text{Female}) + \gamma_{04}(\text{Choice}) + \gamma_{10}(\text{Affect}) + \gamma_{20}(\text{Classroom}) + u_{0j} + u_{2j}(\text{Classroom}) + \varepsilon_{ij}$

Model 2:
Level 1: $Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Affect}) + \beta_{2j}(\text{Classroom}) + \varepsilon_{ij}$
Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{STEM Interest}) + \gamma_{02}(\text{Minority}) + \gamma_{03}(\text{Female}) + \gamma_{04}(\text{Choice}) + u_{0j}$
$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Choice}) + u_{1j}$
Mixed Model: $Y_{ij} = \gamma_{00} + \gamma_{01}(\text{STEM Interest}) + \gamma_{02}(\text{Classroom}) + \gamma_{03}(\text{Minority}) + \gamma_{04}(\text{Female}) + \gamma_{05}(\text{Choice}) + \gamma_{10}(\text{Affect}) + \gamma_{11}(\text{Choice}) + \gamma_{20}(\text{Classroom}) + u_{0j} + u_{1j}(\text{Affect}) + u_{2j}(\text{Classroom}) + \varepsilon_{ij}$

Results

Youth Choice to Enroll

In a preliminary survey, youth responded to a question asking, "Whose idea was it to sign up for this program?" The frequencies of student responses were as follows: (a) Student chose but somebody else (usually a parent) also chose (45%); (b) Student chose and nobody else chose (22%); (c) Student did not choose (the decision was made entirely by someone else) (33%). The first two options were collapsed into a single category, as preliminary analyses showed they did not differ from one another in terms of their association with engagement. The result is a dummy coded variable called student chose that is equal to 1 if the student chose (67%) and 0 if the student did not choose (33%).

Describing Youth Experience

Means, standard deviations, and Pearson correlations of all study variables are displayed in Table 2. Mean levels of engagement, affect, and pre-program interest are above the midpoint of the scale. On average, youth reported being "somewhat" engaged (M = 2.88), experiencing "somewhat" high affect (M = 2.75), and prior to the program were "somewhat" interested in the program (M = 3.12). As expected, there was a positive, moderate correlation between momentary affect and engagement (r = .57, p < .001), and a small but significant correlation between distal choice and engagement (r = .14, p < .001). Pre-program interest was significantly correlated with choice, affect, and engagement, though the magnitude of all correlations was generally small (r = .13, .14, and .10, respectively, p < .001 for all). These initial correlations are suggestive that multivariate analyses may be warranted to identify independent and interactive associations among the variables of interest.

Table 2
Descriptive Statistics and Correlations

	1	2	3	4	5
1. Engagement					
2. Affect	.57***				
3. Pre-Program Interest	.10***	.14***			
4. Choice	.14***	.25***	.13***		
5. Classroom	.00	-.13***	-.06**	-.20***	
Mean	2.88	2.75	3.12	0.67	0.64
SD	0.93	1.08	1.04	-	-
Minimum	1.00	1.00	1.00	0.00	0.00
Maximum	4.00	4.00	4.00	1.00	1.00

Note: Correlations for choice and pre-program interest were examined at the level of the experience sampling method signal, rather than the person.

** p < .01, *** p < .001

Relationship Among Choice, Affect and Momentary Engagement

Unconditional models were examined to ensure that hierarchical linear modeling was warranted. The Intra Class Correlation of the two-level unconditional model (moments tested within individuals) was .38. In other words, 38% of the variance in engagement is observed between persons, which suggests the need for hierarchical linear modeling. Fit indices were examined to investigate whether a three-level model (moments nested within individuals nested within programs) fit the data better than a two-level model. Less than 2% of the variance in engagement is observed between programs and the likelihood ratio test suggested no difference in model fit between the two- and three-level models (p = .31). In the interest of parsimony, two level models are presented here. Across all models, effect sizes are reported using f^2 as suggested by Cohen (1988) and are denoted by *ES* (i.e. small effect = .02; medium effect = .15; large effect = .35). Affect (a level-1 predictor) was group-mean centered (i.e., β_{0j} is the unadjusted mean for person j) and pre-program interest (a level-2 predictor) was grand-mean centered (i.e., β_{00} reflects the average across all youth). Centering rating-scale measures in this manner is recommended to promote ease in the interpretation of results, as coefficients can be interpreted relative to the person or group average, rather than to a value of 0, which is often meaningless (Raudenbush & Bryk, 2002). The remaining variables (which were all dichotomous) were left uncentered.

Table 3 presents results for two hierarchical linear models examining the relationships among choice, affect, and momentary engagement, including all proximal and distal controls.

Table 3
Relationships Among Choice, Affect, and Engagement

	Model 1		Model 2	
	Engagement		Engagement	
Fixed Effects	*B*	*SE*	*B*	*SE*
Intercept, β_{00}	2.38***	0.18	2.38***	0.18
Pre-Program Interest, β_{01}	0.04	0.04	0.04	0.04
Minority, β_{02}	0.24	0.18	0.24	0.18
Female, β_{03}	-0.06	0.09	-0.06	0.09
Choice, β_{04}	0.32***	0.09	0.32***	0.09
Affect, β_{10}	0.41***	0.03	0.39***	0.05
Choice, β_{11}			0.02	0.06
Classroom, β_{20}	0.14***	0.03	0.14***	0.03
Random Effects	σ^2		σ^2	
Intercept, r_0	0.32***		0.32***	
Affect, r_1	0.08***		0.08***	
Level-1 error, e	0.37		0.37	

Note: Due to missing data, analyses included 176 individuals and their 2654 associated experience sampling method responses. The reference group for Choice is *Student Did Not Choose* and the reference group for Classroom is *Field Experience*. Minority status included Hispanic, Black, Multi-racial, and Asian/Pacific Islander. Models were ran controlling for age as well, but there were no significant differences in the estimates. Degrees of freedom for hypothesis tests regarding coefficients were obtained using the Satterthwaite approximation implemented in the lmerTest package (Kuznetsova et al., 2017).

***$p < .001$

For both models, no significant relationship with the outcome was found for minority status, gender, or pre-program interest.

Model 1 examined the relationship among choice, affect, and momentary engagement independently. Results indicate that relative to youth who reported no choice in the decision to enroll, youth who took part in choosing to attend the summer STEM program reported higher engagement ($\beta_{04} = .32$, $p < .001$, $ES = .02$), even after controlling for pre-program interest, minority status, gender, and location. Results also indicate that youth reporting higher levels of affect report higher engagement ($\beta_{10} = .41$, $p < .001$, $ES = .28$), controlling for pre-program interest, minority status, gender, and location. Further, when youth were participating in the classroom, they reported higher levels of engagement ($\beta_{20} = .14$, $p < .001$, $ES = .13$) compared to when they were participating in a field experience. Even though the bivariate correlation between pre-program interest and engagement was statistically significant, the relationship between these two variables was no longer significant once other variables were entered into the model.

With the addition of the interaction term for choice and affect in Model 2, positive, independent effects for both choice ($\beta_{04} = .32$, $p < .001$, $ES = .02$) and affect ($\beta_{10} = .40$, $p < .001$, $ES = .28$) remain, and the coefficient for the interaction was not significant. The effect of being in the classroom (compared to being in the field) persists in this model ($\beta_{20} = .39$, $p < .001$, $ES = .13$). It should be noted that the variance component for the slope of affect is significant, suggesting that there is significant variation across persons with respect to the relationship between affect and engagement, but the choice to attend the program does not explain any of this between person variation.

Particularly for studies that do not use experimental designs, it can be important to determine how robust an inference is to alternative explanations. One approach to addressing this is sensitivity analysis, which involves quantifying the amount of bias that would be needed to invalidate an inference (hypothetically, this bias might be due to omitted or confounding variables, measurement, missing data, etc.). Using the approach described in Frank, Maroulis, Duong, and Kelcey (2013), we carried out sensitivity analysis for inferences we made relative to our key findings[2]. The result is a numeric value for each effect that indicates the proportion of the estimate that would have to be biased in order to invalidate the inference: higher values indicate more robust estimates in that the inferences would still hold even if there were substantial bias in the estimate. For the effect of affect upon engagement, we determined that 84.94% of the estimate in Model 1 and 73.22% of the estimate in Model 2 would have to be due to bias to invalidate the inferences about these relationships. For the sensitivity of the effect of choice in Models 1 and 2, we found that 41.95% and 42.13% of the estimate would have to be due to bias to invalidate the inference, respectively. For the effect of location 54.97% of the estimate in Model 1 and 55.30% of the estimate in Model 2 would have to be due to bias to invalidate the inferences. These large values across all the sensitivity analyses conducted are considered high relative to prior studies using this method (see Frank et al., 2013 for many examples), and suggest that these findings are likely robust in light of possible confounding variables (such as covariates that were not included in the analyses in this study) and other sources of potential bias. Further, we can consider the impact of data that is not missing at random. A small number of missing responses associated with null effects could invalidate inferences about key findings assuming the percent bias needed to invalidate the inferences is small. Considering the large proportions of estimates that would have to be biased to invalidate the inferences made, we can conclude that these findings are robust in light of the data that is presently missing.

Discussion

Considering the established links between participation in out-of-school time STEM programs and long-term interest in STEM (Dabney et al., 2012; Mohr-Schroeder et al., 2014), it is important to understand how to create engaging experiences for youth attending these programs. As distal and proximal processes may impact momentary engagement, we sought to understand the relationship among choice to attend, momentary affect, and momentary engagement through multiple data collection techniques (i.e., traditional surveys and experience sampling). Multilevel modeling suggested that choice is a consistent predictor of engagement. Further, affect appears to have additional positive effects over and above choice. No interaction effect between choice and affect was found, suggesting that choice did not help to explain the variation that occurred between persons in the relationship between affect and engagement. We discuss these and other key findings in detail and implications for practice and future research in the remainder of this section.

Choice as a Predictor of Engagement

We found that youth who took part in choosing to attend the summer STEM program reported feeling more engaged compared to youth who did not take part in choosing to attend the program, even when controlling for pre-program interest, location, and other demographic characteristics. This suggests that regardless of adolescents' affective experiences in the program, if youth chose to be there, they experience higher levels of engagement across a broad variety of activities. These findings are consistent with some of the research on proximal choice suggesting that choice leads to adaptive outcomes in the classroom (Patall et al., 2008, 2010). It is important to note that youth decided to attend weeks before the start of the program, suggesting that the effects of choice persisted over time. Thus, choice may be an important factor to consider in planning meaningful summer experiences for youth. Although the effect size for choice on engagement was small, this is not entirely unanticipated as the engagement outcome is a latent construct measured at the momentary level, and is temporally distal from choice. Our effect sizes are consistent with other studies using this type of measurement (see McCoach, Gable, & Madura, 2013).

It should also be noted that choice was correlated with affect as well, suggesting that youth who chose to attend the program have more positive affective experiences compared to youth who did not choose to attend. Both choice and affect show independent effects on engagement beyond their shared variance. Youth who are experiencing low levels of positive affect may still experience benefits from choosing to attend. Further, youth who did not choose to attend the program may still experience high levels of engagement when their program affords them opportunities to experience high levels of positive affect.

Prior research has attempted to disentangle the effects of interest and proximal choice on engagement (Flowerday & Shell, 2015) with the conclusion that interest is truly the factor contributing to engagement, not choice. However, our results suggest a different conclusion. Specifically, distal choice is a significant predictor of

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[2]Sensitivity analysis was conducted using the R package, konfound (Rosenberg, Xu, & Frank, 2018). To obtain appropriate degrees of freedom for the predictors, we used those estimated from the Kenward-Roger approach as implemented in the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2017) in R.

engagement, even when controlling for adolescents' pre-program interest in STEM. Initial correlations indicated a positive and significant (though small) correlation between pre-program interest and engagement, but when accounting for variance due to choice, interest was not significant. Although this does not directly speak to the relationship between proximal choice and interest, it does suggest that distal choice may be more important than pre-program interest when examining youth engagement in program activities. Furthermore, choice alone appears to impact engagement. This suggests that there may be downstream consequences associated with adolescents' decision to attend out-of-school time programs, when considered independently of affect.

Momentary Affect as a Predictor of Engagement

Affect has not been examined thoroughly in science learning contexts (Fortus, 2014); therefore, it was important to explore how momentary affect impacts engagement in multiple science learning settings. Our results suggest a positive relationship between affect and engagement. These findings are consistent with prior research that suggests that affect is positively associated with higher engagement (Linnenbrink, 2007; Reschly et al., 2008). Although, we cannot make causal claims that affect leads to engagement because they were measured contemporaneously, our results are conceptually in line with theory (Pekrun, 2006). Further, a number of experimental studies have shown that affect and emotions do lead to engagement (Efklides & Petkaki, 2005; Meinhardt & Pekrun, 2003).

The Interaction Between Proximal and Distal Processes

We sought to understand whether there was a significant interaction between choice and affect, as it is possible that adolescents' momentary affect may be differently related to engagement due to a distal choice they made. There was no significant interaction between choice and affect, suggesting that choice does not amplify the effects of affect. Youth who experience high levels of affect continue to see a positive impact on engagement, regardless of whether they chose to attend. However, youth who chose to attend the program do see an additional boost in engagement.

Ancillary Findings

One ancillary finding throughout the models was the relationship between location and youth engagement. Results suggest that youth participating in the classroom experience higher levels of engagement when compared to youth participating in field experiences. Although one may expect field experiences to be more engaging than classroom experiences, it is important to note the items used to measure engagement (concentration and effort). As classroom activities are more likely to include traditional school-like assignments (e.g., individual work, lecturing, projects), it is not surprising that youth rated concentration and effort higher in the classroom as opposed to field experiences. Results also suggest that there were no significant differences between male and female youth at the program. Considering that there were no gender differences in engagement, this is promising for the potential of summer programs to broaden participation in STEM areas.

Implications for Practice

There is evidence that distal choices are in fact associated with youth's momentary engagement, though it appears that more proximal experiences such as affect show stronger associations with engagement. Taken together, educators and staff of out-of-school time programs should focus their time on creating positive affective experiences for youth while attending the program, as well as appealing to students directly to enroll in out-of-school time STEM programs. Furthermore, parents may wish to allow their children more autonomy over extracurricular and summer activity choices, as it appears that choice does impact momentary engagement in program activities. Further, it may be important for youth leaders to be aware of whether youth chose to be there, as they may face slightly greater challenges in engaging students. Our results do suggest however that proximal experiences such as affect can compensate for any engagement deficits youth may experience due to choice. As it appears that proximal factors may have the ability to impact momentary engagement more than distal processes, researchers may wish to examine how proximal experiences can be created to compensate for distal influences that may exert weaker but potentially maladaptive influences of engagement. This gives programs the opportunity to influence engagement by making programming decisions about what youth will experience on a daily basis.

Recommendations for Future Directions

Future research may consider other proximal predictors of engagement, while also considering adolescents' decision to attend out-of-school time STEM programs. In particular, constructs such as perceived competence and situational interest have been identified as factors influencing momentary engagement, and so their effects may moderate the effects of choice. Future research should also examine specific activities that promote positive affective experiences and are engaging to youth, as educators may wish to spend more time focusing on those activities. The current study found that youth were more engaged in the classroom than in the field, but diving deeper into the types of activities youth are engaged in through more extensive analysis of the video data may help to better clarify the proximal influences on engagement. Educators in out-of-school time STEM programs have a unique opportunity to appeal to youth by focusing on interesting activities, because they are often not constrained by time or standards that classroom teachers must deal with.

Limitations

Although the number of responses collected is large, the sample size is modest and focused on select out-of-school time STEM programs. Therefore, one limitation of this study is its generalizability to other out-of-school time programs, particularly those focused on content other than STEM. However, the sample consists of underserved youth in two urban areas and is relatively diverse. Still, the results must be interpreted with caution when considering other populations and other out-of-school time STEM programs. Furthermore, it is important to note that this study was conducted in a summer STEM program and that results may not generalize to out-of-school time programs broadly as differences exist between summer and after school programs that often fall under the out-of-school time umbrella.

Another limitation is that students' response rate to the experience sampling method was low, due largely to the fact that youth attendance at these voluntary programs were spotty. This may have limited our ability to sample a full range of experiences from all youth. Further, the response rate was slightly lower for youth who were not involved in the initial choice to attend the program when compared to youth who chose to attend, suggesting that youth who choose not to attend were absent more often. While mean differences in the response rates for those who chose who attend and those who didn't are small, it is possible that the experience sampled for the 'no choice' group is less representative of their experience than the "choice" group.

We also note that our measures consisted of small-scales consisting of one or two items. Because of this, it is possible that we could have missed potential dimensions of our measures. Though this is a possibility when using the experience sampling method, small-scales are deemed acceptable as multi-item scales are often difficult to implement using this methodology (Hektner et al., 2007). This method has been shown to have a high degree of external validity and potentially reduces social desirability and limited recall when answering questions (Sinatra et al., 2015). Research has also shown that reliabilities between short-scales and long-scales are comparable (Gogol et al., 2014).

Due to the design of this study, it is unclear whether the relationship between affect and engagement is causal. However, theory and prior experimental research have made claims that affect does influence engagement (Efklides & Petkaki, 2005; Meinhardt & Pekrun, 2003). Considering prior research on affect and engagement and the fact that choice was measured prior to the collection of the experience sampling method data, we consider that choice and affect both may be predictive of engagement. Further, this study did not explore the mechanism behind the effect of choice on engagement. Future research should continue to explore these issues using an experimental design. Our analyses allow us to examine how choice and affect associate with momentary engagement, but we have not explored whether there are any effects on long-term outcomes such as academic achievement, persistence, or interest in STEM. This is another area future research should examine as this was not our focus of this study. Despite the limitations of this study, the design facilitated a rare examination of engagement at a small grain size. Considering learning and development often occur at a proximal level (Bronfenbrenner & Morris, 1998; Skinner & Pitzer, 2012), it is imperative to study momentary engagement as educators tend to have the most control over activities that occur in the classroom.

Conclusion

This study focused on exploring how adolescents' participation in the decision to enroll in a summer STEM program impacts momentary experiences while attending the program. Student decision-making has been the focus of research as an academic outcome (i.e., course choice, college major choice; Durik, Vida, & Eccles, 2006;

Simpkins, Davis-Kean, & Eccles, 2006), but it has not garnered much attention as an antecedent to proximal processes such as engagement. Our results suggest that youth who took part in the decision to enroll in the summer STEM program experienced higher levels of momentary engagement compared to youth who did not share in the decision to enroll. Further, youth experiencing high levels of momentary affect also experienced higher levels of momentary engagement compared to youth experiencing lower levels of momentary affect. Though our results suggest that there are independent effects of distal (choice) and proximal (affect) processes on engagement, it is still unclear what may be the mechanism behind choice impacting engagement. Although future research is still needed to understand the generalizability of these findings, these results highlight the importance of distal and proximal processes on momentary engagement and have key implications for both practice and future research. For researchers, particularly those involved in work focused on out-of-school time programs in STEM and other content areas, these findings suggest that choice is an important, yet understudied factor that can impact youth's experiences in these programs. Parents may wish to allow their children autonomy in choosing extracurricular activities as it appears this choice may impact momentary engagement. Lastly, teachers and administrators of out-of-school time programs can focus on creating experiences that promote positive affective states among youth. Despite the importance of choice, doing so may help to compensate for adolescents' not choosing to enroll in out-of-school time programs themselves, but still find themselves participating in them.

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