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Expectancies and Motivations to Attend an Informal Science Lecture Series

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This study explored the expectancies and motivations that prompt audiences to attend a university science lecture series. The series features talks by science experts from the host campus and around the USA. Each lecture typically attracts between 300 and 600 attendees, including middle and high school student groups, university students, and families and adults from the area. We conducted 47 semi-structured interviews with attendees in order to evaluate their expectancies and motivations. A template analysis of the interviews was grounded in social cognitive and self-determination theories. Results suggest that participants were mostly driven by intrinsic motivations and acquired strong sensory outcome expectancies, such as novelty and activity. Participants also held physical outcome expectancies, such as social expectancies, though to a lesser extent. Both intrinsic and extrinsic motivations to attend the lecture series were associated with expectancies held prior to the event. Of those expectancies, the novelty, entertainment, and social outcomes were dominant. Other noteworthy outcome expectancies include status and self-reactivity. Parents and teachers held outcome expectancies, not only for themselves, but also for their children and students who attended the talks with them.

Keywords: *Informal science education; Motivations; Outcome expectancies; Self-determination theory; Social cognitive theory*

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Introduction

Building science literacy in public can ensure that citizens around the world are able to have meaningful and productive discussions about science, related policy, and societal implications (Bischoff, Castendyk, Gallagher, Schaumloffel, & Labroo, 2008; McCallie et al., 2009). However, in the USA only 21% of graduating secondary school students have achieved a recommended level of scientific proficiency (National Center for Educational Statistics, 2009).

Research on science education suggests that one way to bridge gaps in literacy is to better engage learners not only in classrooms, but also in such informal settings as public talks, museums, and broadcast programming (Liu, 2009). Informal science learning is unique in that it allows individuals to engage with science on their own terms and develop personal ties with the scientific discourse in ways that are personally relevant (Bulunuz & Jarrett, 2010; Gerber, Cavallo, & Marek, 2001; Tamir, 1990). Research suggests that people's reasons for pursuing informal science programs are different from their reasons for pursuing formal educational programs (Csikszentmihalyi & Hermanson, 1995). For example, Falk, Storksdieck, and Dierking (2007) identify entertainment, enjoyment, and a desire to learn as key motivations for taking part in informal science activities. Conversely, a dominant motivation for engagement in formal science programs is to meet educational requirements or pass formal assessments.

To date, research on informal science learning has focused primarily on enjoyment and learning outcomes (Renninger, 2007). New research can explore a wider range of motivations that drive people to engage in informal science learning. The current study explores the expectancies and motivations that promote public engagement with an informal science lecture series. Expectancies relate to people's beliefs about the experience and motivations drive engagement (Eccles & Wigfield, 2002). Both are important to understanding people's decisions to engage or not engage in informal science learning (Eccles & Wigfield, 2002). Two relevant theories—self-determination theory (SDT) and social cognitive theory (SCT)—guide the current research effort.

This study has implications for informal science education. In particular, it can demonstrate the use of social scientific methods to evaluate informal science education and inform strategies to promote community engagement.

Literature Review

Informal Science Learning

Informal science learning can be distinguished from formal, or classroom, science learning in a number of ways. For example, informal science learning is more spontaneous and lacks an authority figure and the structure of a formal classroom (Csikszentmihalyi & Hermanson, 1995). Informal science learning occurs in less structured environments where individuals are in control of their own learning (Gerber et al., 2001). Such environments are generally outside of formal school

settings and include exposure to and interaction with science through the media, museums, community events, science and nature centers, after-school programs, public lectures, and other informal venues (McCallie et al., 2009). In such 'free-choice' environments (Falk, Donovan, & Woods, 2001), personal relevance, meaningfulness, and curiosity motivate engagement (Bell, Lewenstein, Shouse, & Feder, 2009). Such motivations contrast with those of learners in formal learning environments who anticipate formal assessment from authority figures.

Advocates of informal science education argue that outreach efforts should emphasize free choice and debunk educational approaches that focus on knowledge deficits in need of correction. Free-choice models encourage learners to explore, reflect, be critical, and engage with science in a personally meaningful way (Chittenden, Farmelo, & Lewenstein, 2004). With that in mind, we present a theory-driven qualitative study of self-reported motivations for attending an informal science lecture series. The series of talks, hosted by a large university in the southwestern United States, is explained in more detail below.

Theoretical Framework

The theories guiding this effort are Deci and Ryan's (1985) SDT, which seeks to clarify behavioral motivations, and Bandura's (1986) SCT, which seeks to clarify behavioral expectancies. Both theories appear in prior research on formal and informal education motivations (e.g. Glynn, Taasoobshirazi, & Brickman, 2007; Lavigne, Vallerand, & Miquelon, 2007; Schunk & Pajares, 2001, etc.).

Self-determination theory. SDT describes two categories of behavioral motivation: intrinsic motivations, which originate within the individual and include enjoyment and interest, and extrinsic motivations, which originate externally and include social expectations and rewards (Deci & Ryan, 1985). Constructs from this theory are consistent with constructs from the expectancy value theory, which posits that individuals' decision to conduct a task and their persistence and performance in it are determinant on their confidence in conducting the behavior at hand, and how much they value that behavior (Wigfield, 1994; Wigfield & Eccles, 1992). As such, the interest value in the expectancy value theory mirrors the intrinsic motivation in the SDT, while the utility value in the expectancy value theory reflects extrinsic motivations as defined by SDT (Deci & Ryan, 1985; Deci, Vallerand, Pelletier, & Ryan, 1991; Wigfield & Eccles, 2000).

Intrinsic motivation is the most self-determined, arising when an individual feels competent and autonomous. Intrinsic motivation is seen as integral to learning and creativity, while extrinsic motivation is characterized as less effective toward those ends (Ryan & Deci, 2000). Indeed, in some situations, extrinsic motivations can diminish otherwise intrinsic motivations and result in less committed or effortful engagement (Deci, Koestner, & Ryan, 1999; Deci & Ryan, 1985). A learning environment can boost intrinsic motivation by maximizing autonomy, competence, and relatedness (Sturm & Bogner, 2008). For example, in an informal learning environment, autonomy and free-choice can be motivating when behavioral options match learners'

needs, interests, goals, abilities, and cultural background (Katz & Assor, 2007). In the current study, we draw from SDT to explore intrinsic and extrinsic motivations for engaging in informal science learning.

Social cognitive theory. SCT seeks to explain the cognitive and social predictors of behavior, including expected outcomes (Bandura, 1986). When people plan and anticipate behaviors, they reflect on the outcomes of their own or others' behaviors and use that knowledge to categorize 'successful' and 'unsuccessful' behaviors. This process enables people to form expectations about behavioral outcomes (Bandura, 1986). Bandura (1997) distinguishes between two kinds of expectancy beliefs: outcome expectancy, which is that certain behaviors will lead to certain outcomes, and efficacy expectancy, which is whether or not one can effectively perform the behaviors.

Bandura (1997) further separates outcome expectancies into sensory and physical incentives. Sensory incentives include novel sensations such as new experiences, activity incentives such as enjoyment, and self-reaction incentives such as personal norming. Physical incentives include social expectancies such as engaging with others, status expectancies such as gaining prestige, and monetary expectancies such as receiving money. In this way, these expectancies align with intrinsic (more sensory) and extrinsic (more physical) motivations.

Efficacy expectancies are often explained as self-efficacy, which is people's belief in their ability to plan and execute a particular course of action (Bandura, 1997). The perception of being highly efficacious in performing a task can motivate sufficient levels of effort to achieve a successful outcome. For instance, SCT holds that learners' perceptions of self-efficacy affect their engagement in learning tasks (Bandura, 1986, 2005). Self-efficacy thus links closely with outcome expectancies: people who have high self-efficacy for a specific task are likely to have well-defined outcome expectancies for that task. In the context of education, Bandura (1997; also Bandura, Barbaranelli, Caprara, & Pastorelli, 2001) describes academic expectancies as a determinant of personal performance, course enrollment, and occupational goals.

Research Questions. In the current study, we use both theories (SDT and SCT) to explore intrinsic and extrinsic motivations and outcome and efficacy expectancies for engaging in informal science learning. This study is intentionally exploratory, employing an open-ended, intensive interview protocol. As a consequence, we do not pose theory-driven hypotheses; rather, we ask a number of research questions that were shaped though our consideration of relevant published research prior to data collection.

RQ1: What are people's general experiences with informal science lectures?
RQ2: To what extent are people self-determined to attend informal science lectures?
RQ3: To what extent are outcome and efficacy expectancies important to attend informal science lectures?
RQ4: To what extent are outcome and efficacy expectancies associated with self-determination to attend informal science lectures?

Methods

The purpose of this exploratory research effort was to learn more about audience motivations and expectations for attending hot science cool talks (HSCT), an informal science lecture series, at the University of Texas at Austin. We decided on semi-structured telephone interviews to allow audience members to describe the talks in their own words. Prior to conducting interviews, the research team attended a few lectures in order to understand the structure and format of the lecture series and to develop relevant interview questions. The interview schedule was developed across multiple meetings with the research team to ensure that it was easy to understand and would elicit adequate information related to key variables from SDT and SCT. The final protocol included 50 questions and probes intended to elicit demographic information, general information about lecture attendance (e.g. distance traveled, parking, etc.), motivations to attend the lecture series, and expectancies of lecture series outcomes. Below we describe HSCT in more depth, as well as our recruitment methods.

HSCT Series

HSCT was founded in 1999 by the environmental science institute (ESI) at the University of Texas at Austin as a free lecture series. There are typically three lectures per semester, each of which includes hands-on pre-lecture activities, the featured lecture, and teacher workshops. The pre-lecture activities are designed to encourage audience members to explore and reflect on issues related to the lecture topics. Examples of which include constructing and launching a paper rocket and exploring macro-invertebrates with magnifying glasses. The activities are planned and hosted by graduate and undergraduate science students along with faculty and professionals from state and federal agencies and non-governmental organizations. The teacher workshops are offered for continuing education credits to K-12 science teachers.

HSCT organizers generally target K-12 students and educators, parent/guardians, and the general public through sending out promotional posters to the city schools and advertising through community postal mail and email listservs. The organizers also submit public service announcement requests to local broadcast media organizations, and post the information on free online community platforms, along with their own social media channels. Moreover, HSCT have increasingly included more and better ways to reach underserved communities. For instance, Title 1 schools (schools with a large low-income student population) make up a large portion of HSCT promotional efforts. The organizers also offer transportation reimbursements for Title 1 schools that bring buses with large groups of students and community members to HSCT. On the language and ethnicity fronts, HSCT have recently (beginning Fall 2013) initiated a bilingual Spanish/English Science, Technology, Engineering, and Mathematics (STEM) outreach program targeting schools with large Hispanic and/or Spanish-speaking student populations, which also happen to be primarily Title 1 schools. For this new initiative, speakers visit schools directly to give bilingual presentations of HSCT topics. In general, these are preview presentations, designed

to attract Spanish speakers to the talks, and teachers and administrators are informed then about the transportation reimbursement for buses coming to HSCT.

The featured lectures are held in a large lecture hall to accommodate the 300–600 attendees typical to each event (number based on 2014) and to make use of up-to-date classroom technology. In the events where more people show up than the capacity of the lecture hall, overflow rooms are used to broadcast the lectures on screens for the audiences. Lecturers wear microphones and have two large projection screens to display lecture slides. In addition, a university website hosts live and archived webcasts of the lectures. Following the talk, audience members in the lecture hall and those watching the webcast can engage with the lecturer in a question-and-answer session. The lectures cover myriad topics ranging from the history and future of whales, to the spread of human diseases, to the exploration of Mars by an automated rover. Lecturers are recruited from across the USA and are chosen for the attractiveness of their topic, their ability to communicate their topic effectively to a large lay audience, and their reputation for being at the cutting edge of their research discipline. It is worth mentioning that the organizing institute works with the speakers to hear a practice talk and makes suggestions for better reaching the lay audience and improving or simplifying visual aids. The typical audience is 40% 6–12th grade students, teachers, and parents of students; 40% university instructors and undergraduate and graduate students; and 20% general public (For more information on HSCT, see Banner et al., 2008).

Recruitment

We recruited interviewees at a lecture in September 2011, handing out recruitment postcards, speaking with attendees in person, and making an announcement before the start of the talk. As an incentive to participate, we offered the best-selling popular science book, 'Good Germs, Bad Germs'. Out of the roughly 400 people who attended the lecture, 78 volunteered to be interviewed for our study. Within one week of recruitment, we sent follow-up emails that contained the IRB-approved consent form and a request to schedule the interview for a specific date and time. We completed 47 interviews in October 2011; the remaining 31 volunteers either did not qualify to participate because they were under 18 or they no longer wished to participate. All interviews were conducted within four weeks from viewing the lecture from which they were recruited. Participants were predominantly female ($n = 32$), ranged in age from 18 to 77 ($M = 46.9$) years, and were highly educated, with almost 90% reporting having earned a university degree. Most participants (70%) reported their before-tax household income to be greater than $50,000. All participants had taken at least one science class in high school and/or college. Finally, six of the participants were teachers who taught middle or high school classes. For reasons of privacy and confidentiality, we use pseudonyms when attributing statements to participants.

The interviews averaged 30 minutes and were recorded with consent. Recordings were professionally transcribed prior to analysis. Although our non-probability sampling method does not yield generalizable data, it does allow for a closer look at individual audience members' expectancies and motivations for attendance.

Data Analysis

We analyzed the interviews using a deductive and inductive qualitative approach. As mentioned above, coding was guided by theory, but we were open to emerging themes and interpretations derived from the data themselves. The theories served as the basis for template analysis, which uses predefined codes (e.g. theoretical concepts) to guide analysis as we portioned the data into meaningful pieces of information to reveal patterns and themes (see Coffey & Atkinson, 1996). We used Microsoft Excel to code responses, for example, whether they contained a given expectancy and whether or not it was met.

Consistent with SCT, we coded responses to 'before you started to attend the talks, what were you hoping to get out of them?' using six categories of outcome expectancies: novelty, activity, self-reactivity, social, status, and monetary. Additional prompts elicited more information on each of those expectancies.

Consistent with SDT, we coded responses to 'Why do you attend the talks?' looking for evidence of intrinsic motivation (e.g. interest or enjoyment) and extrinsic motivation (e.g. separable outcomes, such as school credit, meeting people, and talking to scientists).

During the first round of coding, the lead researcher read through the responses and coded the interviews using the theory-based codes. In instances where the data did not fit any of the codes developed from theory, the researcher developed new codes from the data and added them to the code sheet. New codes that emerged included the expectancies of engaging in a college-level education, expectancies of connecting with college campus life, being motivated by the interest of a friend or family member, being motivated by the desire to expose kids to science, and other similarly nuanced expectancies and motivations. Refining the coding scheme in this manner is consistent with template analysis (see King, 2004, p. 259). Prior to the second round of coding, the lead researcher met with the rest of the team to explain and seek feedback on the coding schematic. After those meetings, the same researcher again coded the data using the initial template codes with the emergent codes added. These codes in combination served as the basis of our thematic analysis, where codes represent explicit ideas derived from the data and themes refer to more subtle processes (Rossman & Rallis, 2003, p. 282). Throughout coding, the researcher took analytic notes that further helped to track common and distinct themes within and among interviews. These notes assisted in organizing the findings of the study. Table 1 presents a list of the themes and subthemes found in the data and their association with the theories guiding this study.

Results

General Experience with the Talks

The interview schedule opened with questions and prompts intended to gather information about participants' general experiences with the talks. Those questions allowed us to answer RQ1, which inquires about the general experiences that

Table 1. Theories, themes, and subthemes from the results

Theory	Themes	Sub-themes
SDT (motivations to attend the talks)	Intrinsic motivations	Interest
		Learning/staying up to date on science topics
		Enjoyment
		Entertainment
	Extrinsic motivations	Interest of a friend/family member
		Be on campus/ feel back to school
		Be around the audience/meeting up with friends/feels part of a community/family quality time
		School credit
		Kids/spouse school credit
		Exposing kids to science/ encouraging them to seek higher education
		Exposing kids to college campus
		Continuing education credits
SCT (outcome expectations)	Novel outcomes expectancies	Learn something new
		Have students/kids learn something new
	Activity and entertainment outcome expectancies	To engage/be stimulated/entertained
	Self-reactive outcome expectancies	The need to learn more about some topics (especially controversial ones)
	Social outcome expectancies	Talking science with friends and family
		Role as science information source
		Asking others to go to the talks
		Anticipating meeting people who share interest in science, including researchers and faculty
	Status outcome expectancies (seeking appreciation from others)	Parents expected their children to appreciate them for the activity
		Teachers expected their students and their students' parents to appreciate them for going to the talks
		Teachers who received continuing education credits for attending the workshops sought appreciation from their schools
		College students anticipated that professors would appreciate their attendance and give them extra credit
	Monetary outcome expectancies	Indirect gain
SCT (efficacy expectations)	Self-efficacy	Getting to the lectures
		Understanding the lecture content

people have with informal HSCT. When asked where they learned about the talks, most said that it was family or friends, their children's schools, university emails, or calendar listings in a local paper. Attendance to the series ranged from one lecture (40%) to having attended more than 20 lectures over the years (17%). About 60% of the interviewees had been to two or more lectures. Some had been coming back since the talks started in 1999. Most of the lectures were attended in person. About one-fourth said that they had also seen a talk online.

We asked participants about how were the talks compared to other science learning they experienced in formal schooling. Overall, the participants indicated that the talks were more interesting and entertaining. In particular, they said that the talks were more laid back, easier to follow and understand, and they covered a broader range of topics. This speaks to the deliberately informal quality of the series, as well as the diversity of the invited speakers and topics they bring to their audience.

Most participants attended the talks with others, including friends, family members, or students. About one-fourth said that they attended with their children. Some participants said that attending the talks was their own idea, while others said that attending was the idea of their friends or family, or they attended to get extra credit for school. The time participants traveled to get to the talks ranged between a few minutes (those who live on campus) to about 60 minutes. Parking was one consideration for some of the participants before attending the talks. The topics of the talks were also important considerations for the participants to determine whether or not they attend the talks. Participants said that sometimes the talks coincided with other commitments they had on Friday nights, but they said that it is good that the sponsor of the series sends out the schedule of the talks at the beginning of the year so they can plan ahead.

Participants said that the talks inspired them to think more about different science topics and increased their scientific knowledge. Moreover, they said that they are more aware of science research at the university level, especially at the particular university where the talks take place, and they feel more connected to researchers and to the science community through the talks. Some participants said that they even introduced themselves after the talks to the researchers. Among the participants, all those who are teachers said that they attend the pre-lecture workshops and they use materials from those workshops in their classrooms (CDs, lesson plans, etc.). However, they felt that the talks did not necessarily help their school develop ties with the university. For participants who attended with children, they said that their children learned a lot from the talks and the talks have increased their interest in science and inspired them to seek science careers in the future.

Returning to RQ1, we have found participants to have very positive experiences with the talks and to think that such programs are important to society. They stated that such talks can improve the scientific literacy of people and that it is important for everyone to stay current on science and technology. All participants said that they are planning to attend more talks in the future.

Motivations to Attend the Talks

Our second research question inquires about the extent to which people are self-determined to attend informal science lecture series. In order to answer RQ2, we needed to understand how intrinsically or extrinsically motivated were the attendants of HSCT. Early in the interview, we asked participants about their motivations to attend the talks. Analysis focused on mentions of intrinsic and/or extrinsic motivations. Although some participants described extrinsic motivations, the majority of the participants expressed intrinsic motivations driving their participation in the talks (58%). Table 2 presents the percentages of the motivations named by respondents and their categorization as intrinsic or extrinsic. Intrinsic motivations included interest and learning, as well as enjoyment and entertainment. For instance, one participant said:

> I just wanted to know, it sounded interesting. I like to keep up with things that are going on now, everything's moving so fast and I don't go to class anymore so I don't really hear a lot about developments in science and I'm always interested in things like that. (Annie, 72 years old, holds a Ph.D.)

Another participant described the joy and excitement she gets from attending the talks. She said:

> It's a thrill to be exposed to somebody who is an expert on a topic and have that person explain that topic to me in terms I understand, as a complete novice on the topics ... [Also], it's really neat to be on the campus ... The whole college vibe that you pick up when you wander around the campus is just great ... it opens up the university to anybody in the public ... And I like being around kids so it's neat in the audience to

Table 2. Frequencies and percentages of intrinsic and extrinsic motivations

SDT Motivations	Specific motivations	Frequency	Percentage	Total
Intrinsic motivations	Interest	23	27	58%
	Learning/staying up to date on science topics	16	19	
	Enjoyment	8	9	
	Entertainment	2	2	
Extrinsic motivations	Interest of a friend/family member	5	6	42%
	Be on campus/feel back to school	2	2	
	Be around the audience/meeting up with friends/feeling part of a community/family quality time	5	6	
	School credit	2	2	
	Kids'/spouse school credit	10	12	
	Exposing kids to science/encouraging them to seek higher education	6	7	
	Exposing kids to college campus	2	2	
	Help with teaching	3	4	
	Continuing education credits	1	1	

> see these 10 year olds or even 5 year olds start out bored, maybe start looking at their mom whining and then they get caught up in something . . . recognizing that it's going on with you too. (Wanda, 54 years old, holds a college degree)

Extrinsic motivations included receiving school credit for the self or a family member, socializing with the science community, having quality time with friends and family, being on a university campus, exposing kids to science, and exposing kids to higher education. For teachers, extrinsic motivations related to getting help with teaching and to gain continuing education credits.

Although extrinsic motivations were mentioned less often, it was common for participants to mention both intrinsic and extrinsic motivations that drive them to attend the talks. For instance, participants would attend for a personal interest, as well as wanting to expose their kids to an experience on a college campus, meet other people who share their interests, and for other extrinsic reasons. For instance, encouraging children to start learning about college was a common motivation among participants. One participant said:

> There were lots of reasons . . . We are starting to encourage [our son] for higher education, getting him on campus as a form of encouragement, taking his interest more in science, it was a great evening out for both of us, we had some good quality time and then when we got there, we saw that other families were doing it as well so I think that really kind of encouraged him. (Matilda, 49 years old, holds a high school degree)

In this case, motivation comes from a family member's interest and encouragement to attend the talks. A second example below describes how one person is generally interested in science and the talks, but his wife's interest is what motivates him to go:

> My wife actually was a science major and in a way it was her ideato start doing this and she has always been fascinated with science. I've always been generally fascinated with science; she was the originator of it. She always gives me the choice of wanting to attend or not, and I know that I must say yes because she wants to. So, she started it and I followed, but I probably, for a lot of them, I kind of have a primary interest in them. (George, 58 years old, holds a Ph.D.)

Teachers also are motivated intrinsically and extrinsically. For instance, they not only have personal interest in the topics, but they also attend to receive continuing education credits and/or to get ideas for motivating their students' interest in science. Another theme that emerged among teachers—which was also present among the rest of the participants—is feeling a sense of community with other audience members.

We also looked at motivation trends in relation to the number of talks attended. Table 3 presents those results. Respondents are mostly intrinsically driven, especially by their interest and learning motivations, regardless of the number of talks attended. Looking at Table 3, 37% of those who were attending their first talk were driven by their interest and 16% by their motivation to learn about science. Those percentages are even more pronounced for people who have been attending 10–19 lectures (88% were driven by their interest and 13% by their motivation to learn) and those who attended 20 or more lectures (50% were driven by their interest and 38% by their motivation to

learn about science). We notice that enjoyment and entertainment motivations are only evident in people who have attended more than one lecture, as they were not mentioned frequently by the respondents who had only attended one talk when we spoke to them (only 5% were motivated by enjoyment), while 25% of those who attended 2 or more lectures named enjoyment as their motivation to attend, and 8% of those attending 2–9 lectures and 13% of those who attended 20 or more lectures said that they were attending the talks to be entertained. This is an interesting finding that indicates that although members of the audience do not think of HSCT when they first start attending them as an enjoyment and entertainment platform, as they attend more of them, entertainment and enjoyment start playing a more important role in driving people to attend HSCT. We also noticed that people who had attended their first talk named more extrinsic motivations than those who had been attending more talks. The only exceptions were parents who have been attending the talks with their children, and who kept holding extrinsic motivations to expose their kids to science and to get them school credit, even after having attended many talks.

Returning to RQ2, we have found that respondents are driven by a wide range of motivations to attend HSCT, the majority of which reflect high self-determination to attend regardless of how many lectures have been attended. This means that respondents are mostly intrinsically motivated to attend the talks, with or without external motivations. However, the specific types of those intrinsic and extrinsic motivations varied across respondents depending on how long they have been attending the talks and who they attend the talks with.

Table 3. Percentages of intrinsic and extrinsic motivations in relation to the numbers of talks attended

Motivations		Number of talks attended			
		1	2–9	10–19	>=20
Intrinsic motivation	Interest	37%	42%	88%	50%
	Learning/staying up to date on science topics	16%	75%	13%	38%
	Enjoyment	5%	25%	25%	25%
	Entertainment	0%	8%	0%	13%
Extrinsic motivations	Interest of a friend/family member	16%	8%	13%	0%
	Be on campus/feel back to school	0%	8%	0%	13%
	Be around the audience/meeting up with friends/ feeling part of a community/family quality time	5%	17%	13%	13%
	School credit (for college students)	11%	0%	0%	0%
	Kids/spouse school credit (for spouse and parents)	32%	0%	38%	13%
	Exposing kids to science/encouraging them to seek higher education (for parents)	21%	0%	0%	25%
	Exposing kids to college campus (Parents and teachers)	11%	0%	0%	0%
	Help with teaching (school teachers)	5%	0%	13%	13%
	Continuing education credits (school teachers)	0%	0%	0%	13%

Outcome Expectancies from Attending the Talks

Our third research question asked about the outcome and efficacy expectancies held by those attending informal science lectures. In order to answer RQ3, we used the SCT, which describes self-efficacy and outcome expectancies (novelty, activity, self-reaction, social, status, and monetary) as linked to behavioral intentions. Thus, we asked participants about what they were hoping to get out of the talks before they started attending them. The novelty expectancy was the most common theme to emerge among participants' answers to this question. Participants said that they were hoping to learn about new topics and keep up with what is new in science. The other common theme that emerged was the activity expectancy. Participants said that they were hoping to be stimulated and engaged in a scientific talk. They also said that they were hoping to be entertained as well. When looking at the expectancies named in relation to the number of talks attended, we notice that the novelty expectation is striking regardless of how many talks had been attended. Table 4 presents that out of all those who had gone to only one lecture, 74% said they expected to learn something new; for those attending 2–9 lectures, 100% said that they were expecting to learn something new and for those who attended 10 or more talks, 88% of them said that they were expecting to learn something new. No striking discrepancies in trends were found across respondents attending a varying number of HSCT lectures. We also prompted participants to reflect a bit more on each of the specific expectancies.

Novel outcomes expectancies. Participants expected the talks to introduce them to new discoveries and breakthroughs in science, and most reported that they did in fact receive new knowledge as a result of the talks. For instance, one participant said:

> I think I was hoping to understand more about each of the science topics. Since science is not my main focus, it was interesting to kind of extend my scientific knowledge (Rita, 58 years old, holds a college degree).

Another participant said: '[Learning about new discoveries and breakthroughs] is one of the main reasons I like to attend' (Dan, 50 years old, holds a college degree).

Table 4. Percentages of expectancies in relation to the numbers of talks attended

	Number of talks attended			
Expectation	1	2–9	10–19	>20
Learn something new	74%	100%	88%	88%
To engage/be stimulated/entertained	16%	0%	13%	0%
Exposure to the topic	0%	8%	0%	0%
Connect with the college	0%	0%	0%	13%
Experience something similar to a college lecture	0%	0%	13%	0%
No expectations	5%	0%	0%	13%
Allow students to learn something new (for teachers)	0%	8%	0%	13%
Spark students' interest in science (for teachers)	0%	8%	0%	0%
Expose kids to science/inspire them (for parents)	21%	8%	0%	13%

Interestingly, this outcome expectancy was mentioned in relation to the self as well as in relation to others. For instance, some parents and teachers mentioned novel outcome expectancies for their students or children to learn about new scientific topics. In addition to acquiring new knowledge, the novelty outcome is also related to having new experiences. The majority of the participants said that they expected the lecture environment to be a new experience for them, especially those who did not study science in college.

Activity and entertainment outcome expectancies. The activity expectancy was also a common outcome. Participants said that they were hoping to be stimulated and engaged in a scientific talk. Almost all participants also said that they expected the talks to be entertaining, along with being informative and educational. One participant said:

> It is fascinating to me, so it was kind of like entertainment. (Oliver, 61 years old, holds a college degree)

Others described the visual elements in the presentations and the excitement from learning about new topics as entertaining. Participants were also entertained by the personalities of the lecturers who were described as 'humorous' and 'passionate about their work'.

Self-reactive outcome expectancies (the need to learn about the topics). We asked participants if they had felt the need to learn more about the lecture topics advertised prior to attending the talks about those topics. Although most participants expressed a general interest in science, prior to attending the talks they did not have a particular interest in the specific topics of the talks. Indeed, some participants were completely unfamiliar with some topics prior to their attendance. However, some participants felt that there were topics that they needed to learn more about and the talks helped fulfill that need. As one participant said:

> I would say, 'I'm glad they're going to talk about that. I do need to know more about that, or that's a good subject for me to learn about' ... I mean anything, especially as you get older, any topic is of some relevance, and what I like is that they are very straightforward ... They lay it out 'This is where we are right now, this is what we know, this is what we don't know, and this is where we are going.'It's solid science from people who were experts in their field and that you feel you can trust. (Teresa, 53 years old, holds a J.D. degree)

In this case, the participant used the talks to learn about topics that might be controversial. By attending these talks, the participant learned where science stands and some of the lingering uncertainties. In that regard, the talks can be viewed as having a self-reactive outcome for the participants, such that people attend the talks because they feel that they do not know enough about the topics and they did not have other credible sources from which to get such information. A few participants said that they were trying to learn more about some of the topics prior to the talks and that they found the lectures to be a good resource to learn about it. Others said that they had not thought about those topics before or felt a need to learn more about them, but they sounded 'interesting'.

Social outcome expectancies. Almost all participants expected social outcomes from the talks, which manifested in various forms that we describe below.

Talking science with friends and family. The vast majority of participants reported that they discuss science topics with their friends and families and that the talks give them something to talk about. Participants said that even before they started to attend the talks, they anticipated that the lectures would allow them to share the information they learned with others. This was especially the case for teachers and parents who felt that they needed to share the information they learn at the talks with their students or children. The participants seemed to be excited about this social aspect of the talks. For instance, one participant said:

> This last lecture was about the brain and I ended up having a discussion with several people at work about the brain and what it does because we all have elderly relatives and we are experiencing things that are happening with age with these relatives and I felt her lecture was . . . it certainly meant something to me . . . We've sat down at dinner sometimes with our kids and talked about it. Both our daughters have majored in science at [this university] and I don't know if the lectures pushed them in that direction, but I think they helped. (Wanda, 54 years old, holds a college degree)

Role as science information source. The majority of the participants, especially teachers and parents, also said that others turn to them for information about science-related topics. Many mentioned that they anticipated the talks would help them with that role. One teacher said:

> Well people usually ask me, because I teach chemistry, about chemistry, but I mean I have people who ask me things about brain chemistry, for example, and I think the lectures helped me to explain that stuff. (Hailey, 25 years old, holds a college degree)

In some cases, this role as information source extended to children and their peers. In that way parents also said that the talks support their children's roles as information sources in their social spheres. For instance, one parent said:

> . . . my son is very good in science. It's really his favorite subject and he is just generally—it just seems to be very natural, it's just what he likes and what he spends a lot of time studying. He learned even more from these talks and he shares what he learns with his social circle. He's 13 now. In his social circle, kids are always asking him science-related questions and I think he's learned from a number of sources, one of which are these lectures. (Teresa, 53 years old, holds a J.D. degree)

Asking others to go to the talks. Most of the participants said that they invited others to attend the lectures with them. In most cases, they said that people responded positively to invitations. However, participants also noted that receptivity to invitations depended a lot on the people invited, with one participant saying:

> It depends on people's interest in science. Some people have only a peripheral interest and they would never attend and a lot of people who work are just too busy at the end of the day to attend. (Adelaide, 76 years old, holds a college degree)

Anticipating meeting people who share interest in science, including researchers and faculty. Many participants did not anticipate meeting people who share their interest in

science. However, the majority actually did meet other people at the talks and expressed enjoyment at having met others with common interests. One participant said:

> I have met several people there that I now collaborate with through email and other methods. (Dan, 50 years old, holds a college degree)

Another participant said:

> I have met people at the lectures ... It's also fun going out and talking with the students who have their little tables set up outside before the lecture starts. I've kind of enjoyed interacting with some of the students and having them explain what their displays are. (Arthur, 65 years old, holds a DDS)

Similarly, teachers felt that the talks were a good venue for seeking collaborations with other teachers and schools. For instance, one teacher said:

> I met and talked with other teachers at the workshop ... I get some insights on what's going on in some of the schools. That's been a big plus too that I couldn't get otherwise. You can't really walk up to a school and say, 'Hey, tell me what's going on here. What are some of the problems?' ... But at those workshops, I can talk with other teachers and find out what's going and what's happening at schools. (Neil, 77 years old, holds a college degree)

Also, although they did not expect it to be so, many of the participants met researchers and faculty in the pre-lecture activities and in the lecture hall after the conclusion of the talk. Overall, participants had a range of social expectancies for the talks that related to their own social experiences, as well as the experiences of their students or children.

Status outcome expectancies (seeking appreciation from others). Although some participants said that they attend the talks to fulfill themselves, many said that they anticipated that others would appreciate their attending. For instance, parents who went with their children said that they expected their children to appreciate them for the activity. Also, teachers said that they expected their students and their students' parents to appreciate their attending the talks. Teachers who received continuing education credits for attending the workshops also felt that their schools would appreciate their attendance. College students anticipated that professors would appreciate their attendance and give them extra credit for it. In summary, status and perceived rewards among family, friends, peers, and authority figures surfaced as an important outcome of attending the talks.

Monetary outcome expectancies. Participants generally did not believe that attending the talks would improve their earning potential. Only a few teachers said that the talks have the potential to bring them monetary benefits through gaining learning credits that might affect promotion. The monetary incentive from SCT, thus, is not a large factor for those attending HSCT. However, one person from the general public explained how an indirect economic gain can result from attendance:

> I tune into this stuff, so that makes me more abreast of what's going on and it stimulates my capacity or my interest in science or in math but I'm not motivated by it—I don't expect to get richer because I'm attending these lectures, but I expect it'll give me a perspective that will make me more successful ... Indirectly, there'll be a token economic gain. (Neil, 77 years old, holds a college degree)

Self-efficacy of the audiences. In hopes of understanding participants' self-efficacy in relation to attending the talks, we identify instances where matters of self-efficacy may affect motivation to attend the lectures.

Getting to the lectures. Participants generally did not anticipate any trouble getting to the lectures. A few of the participants, however, said that they were unfamiliar with the campus and were somewhat worried about finding the lecture hall or parking. Most of those participants, however, said that they did not have the trouble they anticipated. Only a few people said that it was hard for them to find parking spots close to the lecture hall or find good seats to view the lecture.

Understanding the lecture content. The majority of the participants expressed confidence that they would understand the content prior to attending. Those people perceived the talks as being geared to the whole community, including children, and thus did not anticipate comprehension difficulties. For instance, one of the participants said:

> I wasn't expecting I wouldn't understand it because I just assumed that the professors or the lecturers would be giving the lectures to a public audience and were not speaking to a bunch of their colleagues or professionals . . . you know . . . that type of thing it might be a different story, but they were speaking to a general audience, so I didn't expect it would be too difficult. (Greg, 59 years old, holds a college degree)

However, a few participants mentioned some apprehension that they might not understand the content. For some, this presented an interesting challenge and they anticipated enjoying the challenge. As one participant said:

> I have enjoyed that sort of challenge . . . I didn't feel intimidated, only challenged to learn something new. (Cynthia, 43 years old, holds a high school degree)

After attending the talks, most participants said that they found no trouble understanding the content. The talks were clear and they learned from them. Some participants felt that the talks appealed to audiences with a range of prior knowledge. For example, one participant said:

> Even as an adult who knows a lot about science, and thinking that I knew everything, I was still schooled quite well by the lectures. (Drake, 51 years old, holds a high school degree)

Overall, HSCT attendants felt confident about their ability to get to the talks and understand the content before they even started going to the lectures. Thus, self-efficacy seems to have been an additional factor that motivated attending the talks or that would motivate attending future talks.

Meeting the expectations. We also asked respondents to reflect on whether or not the expectancies that they held prior to starting to attend the talks were met. Such findings can help us better understand the retention rates among respondents. In general, participants felt that the lectures met their expectations. One participant said:

> We were hoping to engage in an outreach program targeted to science, and it was. It was kind of like going to a college lecture but a little more informal and less stressful than

> going to school, but as educational as attending a college class. (Caroline, 50 years old, holds an MBA)

Only a few participants were disappointed with the kind of information presented in the talks, having expected to hear a more academic lecture. Yet, they still believed that the talks were informative. For instance, one participant said:

> I feel like the lecture parts of it were helpful and informative but I feel like it was designed for a more general audience rather than a college level audience. I noticed that there was a large number of grade school children in the audience in the lecture and so I understand that the professor maybe was meaning to target the topic or target the content to a wider audience that looked like school children from 6th grade on to high school who were there. So, in that sense I was little disappointed. (Roy, 38 years old, holds a college degree)

More participants, though, said that they had minimal expectations before going to the talks, but that the talks definitely exceeded their expectations after they started attending. In particular, they felt satisfied by their level of engagement and the mental stimulation they received from the talks.

Reflecting on RQ3, we have found respondents to have mainly novelty and activity expectancies, both of which imply motivations stemming from wanting to learn about new ideas and seeking entertainment and enjoyment. Interestingly, however, we have found caretakers (guardians and teachers) holding similar expectations for the children whom they bring along to the lectures. Those findings help us answer RQ4, which asks about associations between holding expectancies and the level of self-determination. We discuss this in more detail in the discussion section.

Discussion and Conclusions

In this study, we interviewed the audience of an informal science lecture series at a large American university. RQ1 asked about the general experiences with informal science lectures and we have found that respondents who attended HSCT had generally positive experiences with them and were planning to attend more of them. RQ2 and RQ3 asked about people's self-determination and expectancies to attend informal science lectures. We used SDT to explore participants' motivations to attend the talks and SCT to explore their outcome expectancies. We found that expectancies for attending the lectures series were mainly oriented to novelty, activity, self-reaction, social, and status outcomes. Particularly, novelty and activity expectancies were the most relevant and accessible to the participants, while monetary outcomes did not play a big role in participants' thoughts about the talks. Also, participants expressed generally high self-efficacy for physically attending the lecture and for understanding the lecture content. As for the motivations to attend the talks, we found that participants were motivated primarily by intrinsic factors: they described experiences of pure interest, learning, entertainment, and enjoyment, which they expressed as reasons for attending the lecture series. These findings are consistent with prior SDT research on behavioral motivations in free-choice environments. However extrinsic

motivations co-occurred with some frequency, which is a novel finding from this study that suggests the need to recognize the more social aspects to informal science education events.

Our study was focused on the experiences of adults who choose to attend informal science education opportunities. The adult sample that self-selected to be interviewed for this study is generally an educated, middle-aged audience with above average incomes. Participants appreciated the informal qualities of the lecture, as well as the range and timelines of lecture topics. Participants learned about the HSCT through both interpersonal and mediated sources. Focusing on the talks as a platform that brings together families, friends, and people who share interest in science can be an important factor in promoting the talks. Moreover, the value of scientific information learned through the talks needs to be stressed for those who value novelty and emphasize the importance of their status as information sources in their social networks. These findings provide information for HSCT to review its goals and strategies.

Linking Expectancies and Motivations

In order for informal science learning to be useful and effective, it needs to be accessible, meaningful, and goal oriented (National Research Council, 1996). Research suggests that informal science learning is more effective for people who are interested in and motivated to learn science (Renninger, 2007). According to SCT, the various incentives that motivate behavior exhibit certain motivational orientations. People whose outcome expectancies reflect physical incentives are more driven by factors external to the behavior, whereas those whose outcome expectancies reflect sensory incentives are more driven by factors internal to the behavior. RQ4 asked about the association between the level of self-determination and outcome and efficacy expectancies for people attending to informal science lectures. Our findings lend support to the idea that participants were mostly driven by intrinsic motivations and expressed strong expectancies for novelty and activity, both of which are sensory outcomes.

Our findings suggest that in informal settings, science learners' intrinsic motivations are related to a more dynamic set of outcome expectancies. Of the expectancies for which we coded, novelty, activity, and social outcomes were the most prevalent. Status and self-reaction were also important outcome expectancies, though to a smaller degree. Historically, research on informal science has mainly focused on learning and entertainment aspects of informal science platforms (Renninger, 2007). The current study suggests new themes that can shed additional light on the expectancies and motivations that drive informal science learning.

Although social outcomes emerged as an important expectancy after some interviewer probing, they were not as significant a factor as novelty or activity outcome expectancies. Nonetheless, our findings suggest a clear social element to lecture attendance. Specifically, most participants described their experience of the talks as something they do with other people, and this social aspect is a factor that may be leveraged to promote informal talks in the future.

Finally, SCT emphasizes the effectiveness of parents, teachers, and other social models in facilitating children's self-efficacy for learning tasks (Tenenbaum & Leaper, 2003), which we can relate to the results of this study. Among our participants, parents and teachers who brought children to the lectures expressed outcome expectancies for both themselves and the children. Such other-oriented expectancies are perhaps most apparent when some participants describe the novel and entertaining experience that children have to gain. Although we are unsure of how such expectancies influence—or perhaps scaffold—the children's learning experiences, we suspect that such expectancies contribute to a positive social learning environment.

Practical Implications

This study has several important implications. First, we have found that HSCT is frequently attended by audiences who are often intrinsically motivated to experience the talks and eager to learn new things and be entertained. We have found that the interest and learning motivations are pronounced across respondents regardless of how many talks they have attended. However, those who have been to more than one talks held more intrinsic motivations than those who were attending for the first time. Also, those attending for the first time held more extrinsic motivations than those who have been going to the talks for a while. This implies that organizers of informal science lectures must make an effort to promote the external outcomes gained from attending the talks especially when targeting new audiences. Returning audiences, on the other hand, are mostly driven by their self-inflicted motivations, such as their interest in the talks, and their motivations to learn and feel entertained.

Respondents also held different expectations prior to attending the talks. Particularly, the novelty expectation was common across most participants, even those who had been attending the talks for more than a decade. This suggests that in order for informal science learning efforts to capture and retain audiences, they need to emphasize novelty. This idea has been emphasized in other studies that have examined informal science education (e.g. Bultitude & Sardo, 2012; Falk, 2006).

Another important implication of this study is the social aspect of HSCT. Respondents who spoke to us often reported that the talks are a place where they spend quality time learning about something new with family and friends. People also reported a feeling of belonging to a community wherein they were able to meet others who share their interest in science. The talks also helped them feel associated with the university campus, which is an important part of their home city's identity. This finding echoes earlier research (e.g. Arcand & Watzke, 2010) suggesting that informal science education efforts need to emphasize a social aspect of their programs.

Another noteworthy finding is that caretakers (e.g. teachers and guardians) are often driven to attend not only by their own personal motivations and expectancies, but also by the interests of the youngsters for which they care (e.g. desire to learn

something new, become a source for scientific information, etc.). This is a very interesting finding that resonates with Falk's work on individual identity motivations to participate in informal science learning environments. Falk (2006) described five categories of people visiting free-choice learning environments (i.e. museums): explorers (curiosity driven), professional/hobbyist (whose jobs/hobbies are associated somehow with the informal science activity at hand), experience seekers (intrinsically motivated to have the informal science experience), rechargers (who use such experiences as a form of escapism from their day jobs and responsibilities), and finally the relevant group in this study, the facilitators, who are involved in those kinds of activities in order to enable the experiences of others who matter to them. Organizers of informal science activities should strive to connect with these facilitators—parents and teachers who originally sought to attend HSCT as a means to get their children and students involved have grown to enjoy the talks themselves and the social and cognitive experiences they provide.

Another implication is that respondents were satisfied with HSCT, believing that their experience attending the talk met their expectations. With the exception of a couple responses where participants said that they expected a more thorough scientific talk, all participants were impressed by the talk's quality and general setting. This satisfaction represents an important reason for the increased attendance and audience retention associated with HSCT and reifies other studies that highlight satisfaction's key role in determining outcomes of participating in voluntary informal science learning activities (e.g. Falk & Storksdieck, 2010). We urge organizers of similar talks to regularly evaluate audience satisfaction so that they can identify and address unmet expectations that may reduce audience retention.

Finally, the self-selected adult sample that we interviewed reveals a skewed demographic of well-educated and relatively high-income individuals. The organizers of HSCT have been constantly trying to appeal to a broader array of schools and communities. For example, they offer transportation reimbursements to help attendees from Title 1 schools and lower socioeconomic status (SES) communities (more details in the background section). Most of those programs, however, have started recently after we had conducted our interviews, so we cannot determine if such programs have further diversified the audiences for HSCT and would have resulted in a different sample interviewed. These efforts hold much promise, however, and may serve as helpful case studies or exemplars for other informal science programs seeking to reach more heterogeneous populations.

Future Research and Limitations

Consumer insight is a critical component in maintaining existing relationships and establishing new ones (Arens, Weigold, & Arens, 1996). Understanding what attracts the current audience to HSCT would offer insights into program design and message crafting, and create opportunities for audience retention. It is important that future studies identify a level of understandability and informality that will remain compelling for this audience. On the other hand, as a community science education effort,

HSCT also needs to appeal to audiences with less education and less experience attending lectures in academic settings. Future studies can investigate the expectancies and barriers that may disincline underserved populations to attend HSCT and similar lecture series and propose outreach strategies that can minimize barriers and maximize positive expectancies.

This study has several limitations. First, its exploratory nature limits our ability to evaluate and extend theory. The interviews resulted in rich data, the analysis of which provides useful insights. A quantitative study that builds on these insights could further clarify the issues the current study raises and test explicit hypotheses. Second, our sample includes audience members from a single lecture. Such a convenience sample limits generalizability to the whole HSCT audience and, certainly, to audiences of other informal science lectures. Since we only interviewed adults, we did not hear from a large portion of HSCT audiences who are young and who may be driven by different motivations and hold different expectancies than adult guardians or teachers who accompany them to the talks. Because many young attendees are not accompanied by their parents—they attend with teachers, scout leaders, etc.—we did not have the ability to obtain parental permission at the event. Therefore, we did not approach minors and instead focused on adults with the anticipation that follow-up research could focus on minors. However, we made sure to ask about the experiences of those who came with children under 18 years of age. Future research should look closely at the experiences of middle and high school students who attend informal science lectures to explore how those experiences are different from the science they experience at school.

Despite these limitations, this study identifies a range of expectancies and motivations that can inform wide-ranging studies of why people engage in informal science learning. Our findings suggest that various outcome expectancies form a motivational base whose orientation—be it predominantly intrinsic or extrinsic—affects the decision to attend HSCT, and importantly, to attend the talks consistently. Some expectancies are more related to intrinsic motivations, which tend to promote better learning. Other expectancies are more related to extrinsic motivations, a reduced sense of self-determination and restricted learning outcomes. Indeed, previous research has documented learning differences between people who are intrinsically and extrinsically motivated (Deci, Koestner, & Ryan, 1999). Future research of informal science lectures might use quantitative methods to study relationships among motivation orientation, content recall, topical interest, social norms, self-efficacy, and other factors. In particular, future research might seek to numerically operationalize the themes this study identified. Such testable variables would help explain participation in various informal science education programs.

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