Science Engagement and Identities in Everyday Family Life

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Abstract: This self-ethnography investigates what science engagement looks like in everyday life of a "science family" and how science identity emerges through such engagement. I systematically analyze recordings made over a year of science engagement in one family, showing how science was infused in many aspects of its life. However, whereas this engagement supported the development of a science-person identity for one child, it worked to develop a science-antagonist identity for the other. To explore how positioning and roles may help elucidate such local variation, I zoom in on the moment-by-moment interaction in one illuminating event. The analysis reveals how repeating identification within everyday family interactions can help explain differences in identity development. It suggests considering informal science learning environments also as leading to alienation from science and exploring how equal access to science is denied in subtle ways that go beyond socio-historical categories.

Keywords: identity, roles and positioning, family learning, informal science learning, parent-child interaction, self-ethnography, socio-cultural theory

Introduction

Scholars have been increasingly studying the development of a science-related identity with an eye to how young people develop aspirations for a science career, and how they persist in or drop out of the so-called science pipeline (e.g., Calabrese Barton et al., 2013; Carlone, Scott, & Lowder, 2014; Hazari, Sonnert, Sadler, & Shanahan, 2010). Research has looked into ways such identity is shaped in school (e.g. Brickhouse, Lowery, & Schultz, 2000), informal settings (e.g. Calabrese Barton & Tan, 2010) and across contexts (Bricker & Bell., 2014; Zimmerman, 2012). That research predominantly attributes variation in science identity development to socio-historical constructs, such as race, gender, and ethnicity and it often demonstrates how families and other informal learning environments afford the construction of science identity. Rarely does research look into the ways informal settings can also lead to alienation from science. Taking a self-ethnography approach, this study focuses on one family, aiming to: (1) provide a rich account of everyday science engagement in a *science family* (i.e., a family rich in science habitus); and (2) shed light on how science identities (a *science person* and a *science antagonist*) emerge through science engagement in such a family.

Theoretical framework

Identity

To study science identity in family life, I draw upon approaches to identity as fluid, situated, and constructed through activity and especially talk (e.g. Holland, Lachicotte, Skinner, & Cain, 1998; Wortham, 2006). These approaches broadly define identity as "the social positioning of self and other" (Bucholtz & Hall, 2005, p. 586), maintaining that what people do, through language and other activities, is a way of constructing who they are. Identities are constructed in a process of situated learning that involves participation in practices of knowing, talking, doing and being and thus becoming part of a community of practice (Lave & Wenger, 1991). The way novices participate in the community's practice, accept, reject or ignore its practices, and the way others respond to that, shape their identities. Thus, people are identifying and being identified as members or non-members of a community (or: as a "kind of person", Gee, 2000, p. 99), through their interaction with others.

Identity is thus a social and cultural construct emerging as a product of interaction, and not an internal psychological construct that is the source of interaction. Identity is co-constructed by a person and the people with whom s/he interacts (Gee, 2000). This perspective highlights the temporary interactional positions and roles participants play (e.g., the collaborator or the antagonist) or are assumed to be playing. Self-identifying includes playing particular roles of who one is and who s/he wishes to be. Other-identification includes recognizing these roles or assigning other roles. Whereas identity "can change from moment to moment in the interaction, can change from context to context, and of course, can be ambiguous or unstable" (Gee, 2000. p. 99), repeated positioning and roles accumulate through time to stabilize a person's identity vis-à-vis a certain community, its members and practices (Calabrese Barton et al., 2013).

Science identity

I conceptualize a *science person* identity as "positioning oneself (deliberately or not) and/or getting positioned as a “good” science participant" (Carlone et al., 2014, p. 839). I view a science identity not as what someone says about her attitudes to, abilities in, or aspirations in science, nor as simply her feelings towards or actions with regards to science. A science identity emerges in a local setting, constrained or afforded by available resources, constructed by an individual's performance and the way s/he is recognized as a science person by meaningful others (Carlone & Johnson, 2007). Science identity is both situationally emergent and cumulative across time and context. Through years of engagement with science, people develop patterns of positioning and participation. Calabrese Barton and colleagues (2013) named this development "identity trajectory" (p. 65). A growing body of research indicates that science learning trajectories are determined by the age of 14 (e.g., Tai, Liu, Maltese, & Fan, 2006) circumscribed by socio-historical constructs, such as, race, ethnicity and gender (Archer et al., 2010; Brickhouse & Potter, 2001; Carlone, 2004).

Research predominantly demonstrates how school science constrains identification with science whereas informal settings afford it. For example, Carlone et al (2014) showed how school disrupted the science identities of three adolescents whom she followed from 4th to 6th grade. In contrast, Calabrese Barton and Tan (2010) illustrated how a voluntary science program afforded opportunities for urban youth to position themselves as community science experts. In a later study, they (Tan, Calabrese Barton, Kang, & O'Neill, 2013) showed how out-of-school settings provided STEM minded girls with a wide variety of resources and positioning, affording them with opportunities to identify with science, in ways that were not available in the school context.

Science identities in family life

Family plays an important role in shaping students’ engagement in, aspirations towards, and identification with science (e.g., Aschbacher, Li, & Roth, 2010; González, Moll, & Amanti, 2006; Bricker & Bell, 2014; Zimmermann, 2012). Archer et al (2012) used the concept of "family habitus" (drawing on Bourdieu, 1984, 2001 and Bourdieu & Passeron, 1979), that is: the family's values, resources, everyday practices and identifications, to explore the extent to which families construct a collective relationship with science and the extent to which this is shaped by their possession of particular sorts of economic, social, and cultural capital. They examined how the everyday family "landscape" shapes, constrains, or facilitates engagement in science, making science aspirations more thinkable for some children than others. Based on interviews and surveys, they found that while a family’s social structural location (e.g., their ethnicity) was important, family attitudes to science and their encouragement and fostering of science in their everyday life had a greater influence on student science aspirations. In the families that they characterized as "science families", science was prevalent in everyday life; children were provided with opportunities, resources, and support to develop a practical ‘feel’ and sense of mastery of science as well as a perception of science as desirable. Many of the parents themselves held science degrees and/or were working within science-related fields. Many of these families held a sense of science being "what we do" and "who we are". Rather than "just another subject", science diffused into all aspects of family life, including daily conversation, and family leisure activities. Nevertheless, in some families, "despite a strong ‘push’ toward science from their parent/s, children did not seem to express a correspondingly high personal identification with (or aspirations toward) science" (Archer et al., 2012, p. 15). This study did not, however, look into the ways in which such "incompatible" identities develop. For example, do children in such families fail to develop "correspondingly high personal identification" or do they develop antagonism towards science? Does this happen "*despite* a strong push" or perhaps *because* of this push?

While scholars recognize the important role families play in children science identity development, we lack accounts of how everyday family science engagement affords and constrains science identity development (for exceptions see Bricker & Bell, 2014; Zimmerman, 2012, Calabrese Barton et al., 2013). The current study contributes to this line of research by exploring how science identities emerge in a science family through everyday engagement with science. This exploration is based on intensive yearlong participant-observation data collected through self-ethnography.

Research objectives

The objectives of this study are twofold:

1. To provide an account of what science engagement may look like in everyday life of a science family.
2. To explore how science identities are shaped through science engagement in such a science family.

Methods

Direct observations of family everyday interaction around science are not easy to obtain, particularly interaction at home, as it spontaneously instigated, unfolds and dissolves. To meet this challenge, in this study I took a self-ethnography approach. I observed and recorded family science interaction throughout one entire year in my own family. Self-ethnography is a study in which the researcher describes a cultural setting which s/he is a "natural" part of. S/he works or lives in the setting, using the experiences in, knowledge of and access to empirical accounts to study the setting (Alvesson, 2003). Previous self-ethnographies by a parent-researcher demonstrate the benefits of such an approach as well as some of its challenges (Vedder-Weiss, 2017; Long, 2004; Yoon, 2012). Whereas in ethnography the researcher usually needs to "break in" to the lived experiences of the "natives" and "make the strange familiar", in self-ethnography s/he needs to "break out" of the familiar, implicit, and taken for granted and make the familiar strange (Alvesson, 2003). To develop such analytic distance, I used linguistic ethnographic methods (Rampton, Maybin, & Roberts, 2015). In addition, I shared the data and my analysis with my family (providing a member check) as well as with colleagues who acted as critical friends.

I acknowledge that the involvement of this study in my family life may in itself have invoked certain behaviors, affecting the interaction and the children's identity formation. However, I suggest that the emphasis this study might have induced on science in my family is aligned with the study objectives: to study science engagement and identity formation in families with a "strong push towards science" (Archer et al., 2012).

Context and data collection

My family consists of a mother (me) who is a science educator and an educational researcher (43 years old at the time of data collection), a father (55 years old) who is a plant biologist, and three boys aged 15, 11 and 8.5. The data for this study was collected during the year 2012-2013 when we lived in Australia for one year due to a sabbatical leave. We usually live in Israel. Throughout this year, I audio recorded events where family members engaged with science content or practice. I regularly had available an audio recording device, which I could switch on when noticing science engagement. I acted as either an-participant-observer or as a mere observer (e.g., when the children were playing among themselves and I have placed the recorder close to them without physically attending). In total, I audio-recorded 305 events amounting to a total of 26 hours and 52 minutes (with events ranging from 30 seconds to 66 minutes each). In addition, I took field notes, commenting on the audio-recorded events or describing events which I did not audio record. Family members were (and are) aware of the study and repeatedly expressed their active consent to participate.

Analysis

Starting with an exploratory phase, I reviewed the entire data corpus, listening to the audio-recordings, going through my field notes, and writing for each event a research memo summarizing the flow of affairs, including participants, the setting, scientific content or object, scientific and engineering practices (drawing on the NRC 2012 framework for K-12 science education), materials and tools, disciplinary affect (drawing on Jaber and Hammer, 2016), artefacts and any other features that attracted my attention.

I then reviewed the research memos, searching for events that appear illuminating in terms of differing patterns of participation between the two children or in terms of positioning, recognition, and roles. I repeatedly listened to these events, using linguistic ethnographic methods, trying to make sense of what was happening and what may explain differences in participation (Rampton, 2007). Then, I used micro-analytic methods to analyze the sequential unfolding of episodes, which included proceeding slowly through the transcript, asking at each line "What is the speaker doing?"; "Why now?"; "How does this turn of talk respond to what proceeded it?"; "What else might have been done here but wasn't?" and so forth. I examined the ways in which the children participated and the ways in which others recognized and positioned them. I paid attention to roles, conflicts, power relations, and bids for recognition and floor. At various stages of the analysis, I consulted with family members and colleagues and incorporated their perspectives on the data as well. The original language of the episode is Hebrew, and I have worked from the Hebrew recording and transcript throughout the analysis.

Findings

The analysis revealed that over the year the family engaged with science in a wide array of settings, from designed settings, such as science museums, to un-designed settings, such as playing in the backyard (Vedder-Weiss, 2017). Scientific content varied significantly, including all STEM domains, focusing on abstract objects (e.g., evolution) as well as on concrete ones (e.g., a Koala). While differentially distributed, family members expressed a wide array of disciplinary emotions, including pleasure of having ideas, surprise, pride, confusion and frustration. They engaged in various scientific and engineering practices, such as modeling (e.g., when designing rubber guns), asking questions (such as why didn't Jack Sparrow's head get wet when he went into the water with a canoe on his head [in the movie Pirates of the Caribbean]), and planning and carrying out investigations (e.g., investigating

seedlings growth rate). Such investigations were often accompanied by argumentation, reasoning, and information evaluation. Interestingly, the family usually used mundane tools and materials, such as rocks they collected outside or rubber they bought in the store. Almost never did they use laboratory tools and materials or science kits, although these were accessible to them. The family produced apparatus such as a water trap, image artifacts such as videos, and texts such as letters.

Throughout the varied science engagement described above, Yoav (8.5 years old) often exhibited engagement behaviorally, cognitively, and emotionally. He usually appeared more interested and engaged in science conversations and experimentation than Shahar. Shahar (11 years old), on the other hand, appeared to quickly loose interest, and often attempted to terminate scientific engagement. For example, on April 16 the family joined Dad on a visit to his workplace. Walking around the research institute, they discussed the fall of autumn leaves and how the connection of the leaf to the stem weakens as it changes its color. Yoav said "Mom, look, I picked a yellow leaf. It detached real easily. A green leaf - much harder". Mom confirmed Yoav's observation. Shahar joined them only after Mom encouraged him to do so. Later, they joined a pea's DNA extraction activity offered by a small discovery center. After the activity, Dad suggested to further concentrate the extracted DNA using his lab centrifuge. Mom, Shahar, and Yoav waited outside while Dad went into the lab to centrifuge the DNA. Yoav looked through the window trying to see what Dad was doing while Shahar sat behind. Yoav insisted they wait until it's ready. Shahar didn't mind. Yoav thought it was "awesome" while Shahar described it as "nice". These examples and many others demonstrate the differences between the science participation of the two children.

Differences in participation in science are often attributed to gender, race, and class (e.g., Archer et al., 2012). However, in this case, the two boys were raised by the same parents in the same everyday landscape. They were exposed to the same family habitus and were afforded the same cultural resources. Why, then, did they differ so much in patterns of participation? The answer to this question is complicated, including social and psychological components as well as historical, local and interactional ones (Bucholtz & Hall, 2005). For example, Shahar was older than Yoav, already entering adolescence, which may have been involved in how he wished to position himself in his family. Yoav, as the youngest in the family, may have been more outgoing in exhibiting exuberant excitement. In addition, perhaps Shahar was simply "naturally" less inclined towards science, cognitive activity or speaking in general? Perhaps he was more of a sports person than a science person? Indeed, Shahar practiced regularly with a basketball team and travelled around the country to compete in youth leagues. Yoav played soccer but this did not take as big a role in his activities as Shahar's basketball. Thus, Shahar's identification as a basketball player may have distanced him from science (allowing Yoav to distinguish himself as a science person). But is there more to it? Many children consistently identify with science, especially adolescents from a socio-cultural background such as Shahar's. Many children like both sports and science. Why then did Shahar, in spite of his family strong science habitus, develop an antagonist science identity?

One illustrative event: "Won't you give up your snack for the sake of science?"

To offer an additional understanding of why the two children differ so much in patterns of participation, in spite of many common conditions, I zoomed in on the moment-by-moment interaction of one illustrative event. Using micro-analysis, I explored how positioning and roles may help explain the local variation in the children's identities.

On October 10, Yoav, Shahar, Dad, and Mom took a day trip to a nature reserve. They climbed a trail up the mountain, and when they took a break Shahar asked for a snack. Mom took out a bag of chips, noticing it was puffed-up. Although this was "Shahar's snack", mom's call "look what happened to it" was taken up by Yoav, who from that moment on became a central participant in the conversation.

Mom compared the bag's current shape to its shape back at home: "at home it was all like squashed, and now at the top of the mountain it's really puffed-up like a balloon". She invited Yoav to touch it. Before Yoav responded, Dad called Mom's observation into question: "I don't think it was squashed at home", but Mom confidently urged Yoav to touch it: "Of course [it was]! I know how [it was when] I took it out of my bag before, look how strong it is here". This time Yoav accepted the invitation, calling excitedly "Yoooo, Daddy, feel here". In so doing, Yoav ruled in favor of Mom's observation, acknowledging that the bag of chips was indeed exceptionally inflated. In response, Dad removed himself from the scenario, saying he had to move out of the sun. Thus, from the very beginning of this interaction, Yoav was positioned (by himself and by his parents) as a competent, effective participant, who has the power to adjudicate between Dad and Mom. Shahar, on the other hand, was excluded. He made no effort to participate, nor did his parents or brother attempted to include him.

With the controversy resolved, both Mom and Dad adopted a teacher role, asking questions to which they knew the answers and providing explanations and illustrations, addressing Yoav and positioning him as their student. Yoav actively participated, answered and asked questions as expected – playing the role of a cooperating

student. Shahar was silent. Finally, Shahar reminded everyone that the bag was brought out for him to eat the snack.

Shahar demanded his chips: "May I eat my chips already?!" but in effect he demanded the end of the science conversation (or lesson) in which he was not a participant. Mom complied, suggesting they continue the inquiry at home where they will see that the bags are usually not as puffed-up: "Remember this and at home I'll show you what it looks like, okay?". This time she used the plural form, addressing both children, which could have afforded Shahar's inclusion in the discussion. However, Shahar excluded himself by refusing to take part in making the bag an object of scientific inquiry, demanding "now open it". His refusal to participate or even to allow the scientific inquiry was aggravated by Dad's attempt to prevent the opening of the bag: "don't open it, let's take it home". This triggered a negotiation between Mom and Dad about the rigor of scientific evidence, with Dad insisting that to prove the bag became puffed-up with increased altitude they need to take "the same one" back home, and Mom arguing they don't: "What, so one's puffed-up and the other isn't?". To end this dispute, Mom turned to Shahar, asking: "Shahar, won't you give up your snack for the sake of science?". Practically, her question put Shahar on the spot, forcing him to declare whether or not he is in favor of science. While Yoav was clearly in favor of science, begging Shahar to eat a different snack instead, Shahar refused and opened the puffed-up bag of chips.

There are multiple explanations for Shahar's behavior. However, whatever the explanation is, the result was that for that moment the family divided into two groups: the science people, including Dad, Mom and Yoav, and the science antagonist, Shahar. Thus, while in this short event, Yoav was identified as a science person, this identification also worked to identify Shahar as a science antagonist.

Analyzing the examples provided above and others, using microanalytic methods combined with ethnographic understandings, yielded the same pattern: repeated positioning, by all members of the family, of Yoav as the science person and Shahar as the science antagonist. The relative positioning of the two brothers consists of the recognition each of them received, the roles assigned to them and the roles they took on. Yoav often *took on* the role of a collaborative science participant, positively responding to his parents' questions or suggestions, while Shahar does not, even when the parents approach them both. Yoav was also *assigned* the role of a collaborative science participant by his parents, for example, when they called or addressed him only (or first), even when Shahar was also present, encouraging him to attend to an animal, phenomenon or idea (e.g., "what do you think, Yoav?"). Both these types of interactions (Yoav taking on a role or assigned a role) positioned him as a science participant while positioning Shahar as a non-participant.

Discussion

I have systematically analyzed recordings of science engagement in one science family throughout one year, showing how science in this family was infused in multiple aspects of everyday life. All family members were involved in various forms of scientific practice and content, in various settings, utilizing various tools and materials, and expressing a broad array of disciplinary emotions. However, whereas this engagement supported the development of a science person identity for one child, that of an interested and capable science participant, it alienated the other child from science. Shahar was not only failing to develop a science person identity. He developed a science antagonist identity. This did not happen *in spite* of the family's push towards science. Apparently, this happened *because* of this push.

Why then in spite of the two boys growing up in the same family, did the family habitus lead to identification with science for one boy but alienation from science for the other? I argue that repeating events of identification within family interaction can, at least to some extent, explain such differences. I follow Wortham's (2006) classroom account of repeating events of identification, in which a student was "routinely identified as a disruptive outcast" (p. 6). I suggest that routine identification through repeating interactions within the family can create a science identity trajectory of science antagonist. Whereas Wortham (2006) and others (e.g., Archer et al., 2012; Calabrese Barton et al., 2013) attribute such processes mainly to socio-historical categories, such as gender, class, and race, these categories cannot explain the differences in identity trajectories of two boys in the same family. The analysis I presented suggests that science antagonist identities may also emerge in other ways.

Family dynamics of roles and positioning are intertwined with science engagement and science identity formation. Thus, the family role in shaping science identity is not limited to affording resources, making science capital available, acting as roles models and encouraging children to engage in science. The family role includes also positioning and recognizing children as science participants and through that equally distributing access to such resources. The distribution of access to resources is not only circumscribed by socio-historical constructs, it is also dependent on subtler cumulative moment-to-moment interactions, in which members of the same family gain more or less access to resources. Thus, also in families with a rich science habitus, children can have limited opportunities to leverage available resources for the development of a science identity.

The role of the science family in shaping its members' science identity is fundamental because, as I demonstrated, everyday science engagement in such a family affords children with abundant opportunities to participate or to reject participation in doing science, in ways that are probably less prevalent in schools. Thus, it is important for parents to develop awareness of the ways positioning and roles are intertwined in everyday science engagement, and with identity formation.

Future research should look into the ways science identities develop in other families, tracking development across even larger time scales, as well as across formal and informal contexts. To enable comprehensive recording of naturally emerging family science engagement, researchers need to develop additional methodological approaches, such as combinations of first-person video recording, reflective journals, and experience sampling methods.

More broadly, this study indicates that informal science learning environments should be considered not only as facilitating the construction of positive science identities but also as leading to the development of science antagonist identities. While research has attended to such issues in school contexts, it's time to start addressing them also in informal contexts, in which people may more easily try out various roles and varied practices. While continuing to investigate and highlight how socio-historical categories work to deny individuals' (and groups') access to science, we should also look beyond these categories to expose how equal access to science is denied in other subtle sometimes less apparent ways.

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