

Chapter 9

Elite British Female Physicists: Social Mobility and Identity Negotiations



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9.1 Introduction

Whilst recent years have seen improvement in women's participation in the broad field of science, there is still work to be done to achieve gender equity in all scientific fields. This is particularly the case in physics; in the UK, women remain the minority from undergraduate to professorship, despite small statistical increases in undergraduate participation between 1970 and the present. Further, the majority of those who participate in science self-identify as middle class. The literature cites many reasons why women and working-class students do not choose to participate in physics, and why they may leave the field. By contrast, there has been little research investigating why women and/or working-class women choose to stay in physics or how they have negotiated obstacles to achieve external esteem and success. This chapter reports on qualitative data from a study exploring the strategies and tactics used by female academics who have had significant success in the field of physics. The researcher used semi-structured, guided life-history interviews to examine how the six women in the sample negotiated obstacles to become international successes in their field. Analysis of the data revealed three significant experiences and identity negotiations that helped the women in this cohort persist in their determination to become academic physicists and to garner accolades and awards: (1) reliance on the self, (2) social support networks, and (3) the construction of a working class hero identity. The implications for the recruitment and retention of UK women in physics are discussed, along with suggestions for policy and practice.

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9.2 Approaches to the Problem

Despite efforts in recent years to address the lack of gender equity in physics, both the numbers and the proportions of women's participation in the UK remain low. Existing research focuses on why women choose not to participate in physics (see Baram-Tsabari and Yarden 2008; Götschel 2013; Kantaria 2012; Stewart 1998), addresses women's participation in science as a general discipline (see Carli et al. 2016; Sikora and Pokropek 2012; Venville et al. 2013), or uses quantitative methods to correlate or predict women's participation (see Hazari et al. 2007; Lock et al. 2013; Nosek et al. 2009; Sadler et al. 2012). This work has been useful for identifying physics as a field rife with socially and academically preconceived notions that favour men's over women's participation. This occurs in a variety of ways—from discriminatory behaviours, to unconscious bias resulting in decreases in self-efficacy or interest. Among other reasons, many women appear to leave physics because they feel that they don't "belong"; their alienation from other (male) physicists makes them feel as though they will always be an outsider to the field.

To investigate this concept of belonging, scholars have analysed and (re)defined the notion of a *physics identity*. From an examination of career aspirations in young children, it is clear that those who tend to persist in physics self-identify as a physicist or as a "physics person" (Archer et al. 2016; Danielsson 2012; Gonsalves 2014; Gonsalves et al. 2013; Johnson et al. 2011). Constructing and adopting this identity seems to help individuals "fit in". Yet a physics identity is often in conflict with a feminine gender identity, and for this there seems to be no easy resolution. The conflict between identities may explain the high attrition of, and low recruitment for, women in physics (Archer et al. 2012; Danielsson 2012). Women often feel as though they must negotiate and potentially compromise their femininity to reconcile feminine and physics identities (Carli et al. 2016; Hazari et al. 2007; Lock et al. 2012). The struggle to achieve a unified self can be overwhelming and laborious, and may be interpreted as a reason to leave the field.

Recent studies have also investigated the intersection between class identity and aspirations towards a physics career. The UK 2007 Department for Education and Skills (DfES) report demonstrated that social class accounts for a great deal of variance in achievement and aspiration, and that working-class males tend to perform (and celebrate) a masculinity that is in direct conflict with academic success (DfES 2007). The ASPIRES project found that working-class students were not recognized as being naturally clever; cleverness was associated with white middle-class males, and because science tends to be highly correlated with cleverness, the field seems to "fit" white middle-class males (Archer et al. 2013; DeWitt et al. 2014). Working-class masculinity (perceived then, to be at odds with a science identity) is exemplified by the concept of *laddishness*, which is characterized by: performances of disruptive behaviour; the objectification of women through banter and "having a laugh"; and in men's appearance or avoidance of exerting efforts towards education (Carlone et al. 2015; Miller-Friedmann et al. 2018; Phipps and Young 2015; Stentiford 2018). Working-class students are further dissuaded from pursuing

science by teachers' stereotypes and the inherent inequality in the UK school system (Archer et al. 2013). Because working-class women associate femininity with being a "mother" and "homemaker", they are even less likely than working-class boys to participate in science. A further disadvantage is that the higher education required for a career in science clashes with these ideal feminine identities (Fuller 2018).

There has been far less attention paid in the literature to women who have achieved success in academic physics, and to the ways in which they have managed real or perceived obstacles to their progress. Looking at gender inequality from this point of view is challenging because there are a limited number of women who have achieved internationally-acclaimed success in physics. In addition, researching this elite group of women would require anonymity on their part to ensure their candour does not threaten their external esteem and position. One notable study investigated scientists in elite universities and found that male and female scientists give different reasons for why gender inequality persists. The research concluded that gendered identity functions as a master narrative (over a science identity), and that women seem to be drawn to the kind of science that resonates with emotional labour (Ecklund et al. 2012). There are also few studies that examine the intersection between working-class women and academic physics, or explore the ways that women in this field negotiate, (re)mould, compromise, and leverage identities to construct a unified self that can achieve professional success.

Using Judith Butler's (1990) theorisation of gender, it is possible to investigate pathways to success for elite female physicists, and better understand the ways in which they have managed the challenges presented in the literature as reasons for attrition. According to Butler (1990), femininity is not a unified concept, but rather a contextual construct, (re)created and sustained through repeated acts and performances. Through the repetition of performance, an individual eventually adopts the identity that the performance implies, as well as the subjectivity that accompanies that identity (Butler 1990; Butler 1993). Butler (1990) acknowledges that notions of gender, and therefore performance and identity are contextual, although she does seem to indicate that there is an overarching master narrative of both femininity and masculinity. Becky Francis (2012), on the other hand, describes boys (males) as performing multiple competing masculinities, and girls (females) performing multiple competing femininities. The mixing and fusing of a variety of dichotomously associated gender performances is called gender *heteroglossia*—when one exists somewhere along the spectrum between masculine and feminine (Francis 2012). Gendered identity in this study will be discussed using dichotomous (monoglossia) terms, masculine and feminine, whilst acknowledging that the participants in the study, as is the case with most people in general, may experience gender heteroglossia. To be sure, most individuals in a society remain attached to gender dichotomy and tend to identify as either male or female, and the participants in this study self-identified as female. Their narratives, however, revealed a different gendered identity that provided insight into their professional success. Brickhouse et al.' (2000) description of identity "accounts for the importance of both individual agency as well as societal structures that constrain individual possibilities," thus positioning

identity as both an internal (“Who am I?”) and external (“How can that person be identified?”) pursuit (Brickhouse et al. 2000). Acknowledging both the internal compulsion to fit in and external influences to “be normal”, this study will analyse common experiences and coping mechanisms through the lens of gendered identity construction, as these identities are formed through imitation, repetition of performance and adoption.

Deterrants to women’s participation in physics, such as gender stereotypes and lack of support in the workplace, have been recognised for a long time and are well researched. Yet actions to counteract these constraints have not resolved the problem of persistent gender inequality. By exploring the experiences of highly successful UK female physicists, this work looks at what constrains women from taking part in physics and, conversely, what has helped them to participate. Their narratives reveal previously ignored factors that have helped women in the UK stay the course in a physics department. A closer examination of their experiences also reveals possible methods for negotiating obstructions or difficulties.

9.3 The Study

To establish the current state of gender inequality in physics in the UK, and to determine which factors would constitute success, I investigated the number of women participating in physics in the UK. Females comprise 23% of physics undergraduate and postgraduate students, 24% of junior faculty, 17.4% of senior faculty, and 12.5% of Professors for the 2016/17 academic year (Higher Education Statistics Agency 2016). These statistics do indeed show that there is gender inequality in UK academic physics, but questions remain: Who are the women in the 12.5%, and how have they managed to circumvent obstacles? The literature gives abundant reasons why women would leave physics, if they decide to participate at all. What can be learned from the small proportion of women who have persisted?

9.4 Research Questions

To begin investigating what experiences senior women in academic physics in the UK have had, and how these experiences have influenced them and their professional pathways, the following questions were explored:

1. For those British women who have persisted through beginning stages and become academic physicists, in which ways have they experienced gender inequality, and which experiences have helped them succeed?
2. What effect has social class had on the participants, and has it been a hindrance or advantage in their pathway towards success?

9.5 Research Methods

9.5.1 Selection and Participants

The research consisted of six qualitative case studies of highly successful, female British academic physicists to investigate the experiences, coping mechanisms, and identity negotiations that have helped them navigate to their current elite status. This study defined successful and elite as those with “close proximity to power or particular professional expertise” (Lancaster 2016, p. 93) who have also achieved international and measurable success in physics. The participants for the study were chosen using the following parameters:

1. Applied for or been awarded the title of Professor (in the UK, ‘Professor’ is the highest academic rank, and a title of distinction awarded to an individual)
2. Been awarded a competitive grant from an internationally recognised organisation and/or scheme (such as the European Research Council [ERC] grants), *or*
3. Been recognised for her scientific achievements by an organisation or institution outside of her university (such as the Royal Society, or Women in Science and Engineering [WISE]) (Miller-Friedmann et al. 2018)

The number of women who have achieved any of these parameters in physics in the UK is small; the participants in this study met at least two and often all three. The participants can, therefore, be referred to as elite (as defined by this study), and successful (as they would likely be defined by their subfield peers).

The participants were selected by cross-referencing the Royal Society Fellowship directory and the European Research Council grant directory. The list of possible participants was narrowed down to those fitting at least two parameters, resulting in a possible pool of 12 candidates, who were invited to be interviewed. Six of the participants responded that they were interested in being interviewed, and arrangements were made to meet. The remaining six either declined the invitation to participate or never responded to attempts to contact. The six participants in this study were all British female physicists who were, or recently retired from being, faculty at internationally competitive research universities. All the participants were White, heterosexual, and five of the six participants had children. The participants ranged in age from 35 to 75; two participants were in the early to mid-career stage, and four were in their mid to late career stage.

9.5.2 Interviews and Analysis

The study was designed to be both confirmatory and exploratory—substantiating the obstacles reported in the literature, *and* discovering how the participants managed these obstacles. Qualitative interviews were chosen as a method of investigation for several reasons. First, the interview is a robust method for exploring meaning

and explanation behind the numbers (Creswell 2003; Creswell and Creswell 2013; Gill et al. 2008). Second, in an effort to discover why women would stay rather than leave, I hoped to both uncover new data and give agency and voice to a minority population. The interview is an appropriate method to enable one to “hear silenced voices” (Creswell and Creswell 2013, page ref). The final reason for using qualitative interviews was to better understand the experiences of women, a critical perspective, as I was approaching the study from a feminist standpoint. Feminist researchers argue that women’s life history narratives as constructed by women provide better insight into “women’s lives, men’s lives, and the whole social order” (Harding 1993, p. 56; see also Hughes 2001; Sinnes 2006). In this research, I used guided interviews to ask specific research questions, and because I sought to compare experiences. I guided the participants through semi-structured life history interviews, looking at the depth and breadth of their experiences, their coping mechanisms, and identity negotiations. The interview schedule was constructed to reflect both confirmation and exploration, and included questions that confirmed theories regarding self-efficacy, support, discrimination, and bias, as well as items that investigated possible reasons for success, such as attitude, gender associations, and positive mentoring. The participants were asked to block out 2 h for the interview. In reality the duration of the interviews varied from 2 h to close to three and a half hours. All interviews were followed with an online follow-up survey on [surveymonkey.com](https://www.surveymonkey.com). This anonymous survey consisted of six (essay) thought items, including: How do you define success?; Do you feel like gender stereotypes are different now to when you were a child?; and, one Likert scale item. The interviews were transcribed and uploaded into NVivo for analysis. Provisional codes (Creswell and Creswell 2013; Dey 1993) were used deductively, and inductive codes were used as they emerged in the data. All the transcripts were read, discussed, and coded by multiple researchers in order to establish reliability. The data were triangulated with the open-ended questions from the follow-up survey, published literature, and discussion with identity scholars in the science education community. All data were determined to be reliable and valid. The names used in this chapter are pseudonyms.

9.6 Findings: Identity Negotiations and Social Mobility

Analysis of the data demonstrated that there were three significant factors common to the participants that helped them participate and persist in academic physics and shift their social class. First, the participants experienced a prolonged period of isolation in their childhoods that impelled them to construct the beginnings of a non-dichotomous gendered identity, the characteristics of which were crucial to their later success. Second, the participants were highly involved in religious and musical groups that provided alternative ideologies to the norm they knew in school, and the alternative philosophies they performed were equally critical to both constructing their identities and succeeding in their careers. Last, the participants’ narratives involved the trope of working-class hero, and this was a fundamental

element to their identities, their perception of self, and their understandings of success.

9.6.1 From Isolation to Reliance on the Self

The participants began their life histories with descriptions of feeling isolated or excluded from their perception of the norm, and detailed the ways in which they coped with their difference. These experiences and subsequent coping strategies appeared to be critically important in guiding the participants towards physics, and in keeping their interest in physics alive throughout their school years. Moreover, the participants continued to employ the coping mechanisms detailed below throughout their lives, which afforded them advantages in their education and careers that helped to propel them to their current successes.

As a result of feeling isolated, the participants developed gendered identities which tended to be ambiguous, multiple, overlapping, and often contiguous rather than compartmented, and yet all were constructed within a heteronormative and traditional matrix. The outlier of this cohort claimed that she had close-knit friendships throughout primary school, but enjoyed working alone and did not take other people's comments seriously. Her narrative indicated that she developed the same coping mechanisms but did not have an exclusion experience similar to the other participants.

Chronologically, the participants' narrative accounts began by describing extended periods of social isolation, principally during their primary school years. According to the participants, they were outsiders, excluded from social groups both in and outside school:

Diane: ...but no, some of it was a bit lonely probably, in retrospect, or maybe I was just always a loner, I don't know.

Caroline: I never felt I belonged. At every stage in my life at school I was always much [different to] everyone else and also seen as teacher's pet. I was hated because I was teacher's pet and I was [different to] them so I was not interested in the same things.

The participants agreed that they were not members of the popular group at school. These perceptions of 'difference' to other children at school and of not fitting in seemed to result in the participants feeling lonely in their estimation. The participants' admissions of exclusion from peer groups in school often led to a discussion of their home environments. In addition to a lack of peer interaction in school, for some participants, feelings of isolation were exacerbated by contentious relationships with their siblings:

Caroline: My sister was horrible to me.

Faith: My younger sister suffered much more than I did from my brother. I was older and therefore had defence mechanisms, she didn't and my parents never noticed – they never knew. It's extraordinary actually. None of us ever told them, we just tried to cope – it was actually quite strange. I mean, they knew that he had a short temper, but they didn't know that he terrorized us.

For most of the participants who reported difficult family relationships in addition to social exclusion at school, their perceptions of isolation were the lenses through which they narrated their childhood. Three main types of defence mechanisms, or coping mechanisms, emerged from the participants' narratives; firstly, "developing a thick skin", secondly, becoming comfortable in working alone, and thirdly, acting less intelligent in order to fit in.

The first coping mechanism the participants cultivated in response to feeling excluded – developing a thick skin – could also be described as developing a high tolerance to the normalising discourse that surrounded them, as well as a greater reliance on polite social conventions to mask resentment or anger. The harassment that the participants experienced ranged from banter and teasing to a range of verbal, physical, and symbolic harassments like those tweeted as #everydaysexism ("Everyday Sexism Project," 2017). In response, instead of reacting angrily (or with embarrassment) to hateful banter or harassment, some of the participants seemed to be less emotionally sensitive to it, and consistently replied in a socially acceptable manner:

Faith: A lot of my year group – friends if you'd like – would essentially tell me that if I wasn't prepared to announce my nationality, then I must be a terrorist. What else was there to discuss? And they would tell jokes that were only funny if you felt that [people of my nationality] were stupid and I had to learn to handle this – I didn't fly off. I learned to tell anti-English jokes and so on. But it reinforces outsider status...

Other participants learned to control their reactions to harassment so as not to evince any kind of physical or verbal response to antagonistic behaviours:

Caroline: I don't remember crying myself to sleep or anything. I suppose you just take it as the norm. You just don't think. You just get on with it...

The participants perceived themselves as needing to cope with various forms of harassment by changing their behaviour and emotional responses; none indicated that they attempted to cope with peer or sibling bullying by preventing the episodes from occurring. As developing a thick skin is an emotional coping mechanism (Berger 2015), the participants appeared to be deeply emotionally affected by incidents of harassment, and yet learned to deflect their hurt. Instead of relying on the opinions of others, which were, according to the participants, often distressing or problematic, the participants began to rely on their own feelings and opinions:

Diane: I've always had the mentality, the policy, that you think for yourself. You decide yourself whether you like something or you don't; you don't necessarily follow the crowds.

This reliance on the self was seemingly useful, in that it helped the participants to normalise their exclusion and gave them agency in their decisions (e.g. "you think for yourself", "you decide yourself"). Relying on their own opinions and being aware of the agency they had in their lives was mentioned as a turning point by most participants in the follow-up survey. The participants reported that, once they had reached this turning point, they decided that they were going to "do what they wanted [physics], no matter what popular stereotypes or other people said." Instead of responding to normalising judgement by conforming to the norm, the

participants *accepted* their marginal status and began to identify as marginal, as the Other. However, their resistance to normalising judgement was more likely defensive rather than offensive: only after constructing a marginal identity post-isolation trauma were the participants able to identify as resistant to the norm.

At the same time, the participants suggested that they were only intimately exposed to one general performance of femininity on which they could learn to model their own behaviour: the femininity of the “mother.” This feminine identity, extrapolated from participants’ comments, was based on heteronormative and outdated versions of motherhood. The participants’ resulting gendered identity was ambiguous and uncomfortable, constantly battling between remaining on the margin and tenuously creeping toward a more antiquated version of the norm. The second coping mechanism that emerged from the participants’ experience of isolation was developing an ability, and for some a preference, for working alone. For some participants, working on their own began as a part of their isolating experience:

Eve: I just got bunged at the back of the room with my own book because I was way ahead of everybody else, so I just, you know, did my own thing, which I was very happy to do.

Interviewer: Were the other kids okay about that?

Eve: Well, I think so. I mean, you had to learn not to boast and things. I think one learns to cope with being clever.

The participants reported that teachers and school administrators were aware of their exceptional intelligence, giving them advanced work or allowing them to take courses at nearby universities. In front of their peers, however, the participants performed an interconnected third coping mechanism—acting out a lesser intelligence to cope with their uniqueness. The participants were judicious in their performance of intelligence, in that they performed it in front of authority figures only, knowing that this would garner the most benefits. The terminology they used to describe being singled out to do advanced work (which reinforced their otherness) included positive terms, such as feeling “happy” or “wonderful.” In fact, the participants reported that they continued to enjoy the work they did on their own from primary school all the way through to their positions as early career researchers. All the participants were involved with projects in laboratories, but also worked alone, and were very comfortable doing so. They described their work as “lovely,” or “a wonderful time,” but clearly indicated that most of their time was spent by themselves:

Caroline: Well, a PhD is always on their own, technically. But, no, it was lovely. It was great and the technicians were very good too. They were very good looking after us. My relationship with my supervisor was... He was... a lovely chap but he was kind of not there a lot of the time. I remember, I mean - not there in the sense that if I wanted to talk to him, it could take a week to find him.

Faith: Oh, no. I’m perfectly happy being alone. I don’t mind company, but I also don’t mind just me. So I didn’t set out to avoid being lonesome.

Whilst studies have suggested that working alone can be damaging to mental health, the participants in this cohort seemed to thrive in that environment (Harnois and Gabriel 2000). This did not mean that the participants had no social interaction, however, but that their social interaction did not occur within educational, academic,

or scientific milieu; the participants all sought social interaction within organised or institutionalised programmes, as will be discussed in the next section.

The defence mechanism of working alone allowed the participants to construct a resistant identity of social and intellectual independence—a masculine performance of autonomy and self-reliance in opposition to a heteronormative feminine performance of reliance on male suggestion or approval. This particular component of the participants' identities can be identified as “resistant” because they made an effort to justify independence as a positive trait. Moreover, they suggested that their isolation during their university years and beyond was voluntary and, at times, preferential to more integrated and collaborative working environments. The participants' choice to extend their isolation into their early careers implied a continued resistance to the norm, and to feminine performances of “social,” “nurturing,” and other qualities that are performed through interaction with others. The participants coped with their extraordinary intelligence by performing their intelligence judiciously (e.g. only for authority figures) which did not change others' opinions of them but kept them socially marginalized.

9.7 Alternative Ideologies

To navigate their feelings of isolation, participants turned to other arenas for social contact, support, and confirmation in their choice to become physicists. In their own estimation, the participants' lack in friendships at school was mitigated by relationships they formed in religious and music groups. In this way, both music and religion helped to construct the participants' earliest physicist identities which solidified their intention and validated their choice, whilst simultaneously making them believe that there was indeed a place where they belonged and were valued members of a group.

There was one outlier amongst the participants who did not report participating in either religion or music, but who was very involved with computer programming and computer games. As such, she was socially involved with other students who had similar interests, and in the ‘B’ group at school (not the popular group, but not the unpopular group). She reported having a rich social life, both in and out of school.

9.7.1 *The Role of Religion*

Three of the six participants were religiously observant, and referred to their beliefs, practices, or religious youth programs throughout the interview. Through their faith, religiously observant participants gained validation in what they believed was their purpose: physics. The denominations to which they belonged (two were Christian, one was Catholic) promoted a kind of faith-associated meritocratic ideology, which

meant that they saw their skills and intellectual inclinations as holy gifts that should not be squandered:

Faith: There was an attitude - which was very clearly stated - “you use the talent you’ve got” - God-given talents have to be used - so if you’re good at something you *should* be good at it. In that sense it was telling you to have aspirations.

The participants felt that their intellectual talents and passion for physics was encouraged by religious doctrine. Religion gave the participants a liberating message to follow their aspirations and pursue degrees in physics because they excelled at the subject. As their religious observance had been established early on in their lives (as a family activity and deeply embedded set of beliefs), the participants reported feeling more closely aligned with religious doctrine than normative (school peer/social) ideology. As the participants’ religious doctrine encouraged them to refine and pursue their God-given talents (interpreted by the participants as their talent for physics), they reported feeling validated in their choice of career path.

The participants did, however, express a contraindicative result by suggesting that their theology validated their masculine performances: for example, their God-given talent compelled them to participate in male-associated physics courses, and validated their marginalisation through the justification “God made me this way.” Whilst, in general, Christian theology is stalwart in its determination of gender roles, promoting a patriarchy based on reproductive possibilities, the participants chose to resist their doctrine-implied status and perform being a “master.” They did so by (re)positioning themselves within their theology to reflect an unmediated relationship to God, through which they could interpret God’s purpose for them without the intervention, negotiation, or interpretation of a (male) religious authority. The participants were again judicious, both in their understanding of theology and in their incorporation of particular aspects of the theology into their gendered identity. This alternative discursive formation allowed the participants to feel as though they were members of the norm even though their gender performance was, in some aspects, disruptive to the gender norms of their theology.

9.7.2 *The Role of Music Groups*

Three of the six participants were involved in musical groups that included orchestras, choirs, and English folk dancing. One respondent was both religiously observant and heavily involved in musical groups. Musical activities and clubs served as a safe space, especially for those participants who were religiously non-observant, where they felt accepted or judged based on their musical abilities rather than on their propensity to fit in:

Caroline: And, I found friendships incredibly difficult. And that’s why music I think became very important at secondary school because in music [difference] wasn’t relevant. It was, you know, oh she is a [musician], good. I had an instant friendship group, as it were, and I think that was very important.

The participants' immediate incorporation into a group made them feel like they were a part of the norm, that they were not the deviants that normative ideology (such as that of their school peer groups) compelled them to believe they were. As in the religious groups, the primary reason for musical groups to meet was not necessarily social in the same way as friendship groups formed in school, but, instead, there was a clear agenda (playing a piece) and a goal (playing a piece [together] correctly/well). Moreover, the musical group was dependent on the participants' individual contributions and the participants were aware that this reliance gave them agency (to turn up, to play her piece well, to be in sync). Unlike their experiences in the classroom or in social environments, the participants were comfortable in musical groups and felt accepted:

Caroline: I very rapidly got absorbed into all the music making which was in itself a problem because they were some very very good musicians and I was a beginner. But they accepted me...

It seemed that for the participants who were most actively involved in music groups, the comfort of being able to supply something that was in demand (i.e. an ability to play a particular instrument) was the impetus for joining and persisting in music groups. The participants felt as though their roles in music were clearly stated (e.g. "I played my part"), and that they were valued members of the group. Here, without the discomfort of social interaction (for the participants had already acknowledged their exclusion from social groups at school) the participants were able to become valued members of a group that supported who they were.

Some of the participants perceived their membership in music groups as being intertwined with social class. Two thirds of the participants who identified as musicians also identified as being working class, but as the participants became more involved with music, they perceived themselves as shifting towards the middle class. This, the participants reported, was helpful in encouraging them to persist in studying physics beyond secondary school. Their families had neither encouraged nor discouraged their intentions to study physics at university, as the participants' parents had not attended university. The participants reported imagining that they might have "gone down the same path", but felt that their involvement with music changed that:

Anne: ...You're almost automatically middle class because you have music every week, you sing a lot, you read at least one book on a regular basis, (both laughing) all that side of things is almost a cultural bridge to oh!, You read other books then, listen to other music. It does help you connect things into that whole circle.

This perception resonates with theories in music sociology, a field which built upon the work of Adorno and Bourdieu, amongst others, to investigate the ways in which musical taste and participation in musical groups and events evidence individual displays of social class (de Boise 2016). Shifting social class, or perceiving a shift in class, was beneficial in helping those participants to feel as though they fit in more during university (since they imagined higher education was a middle-class pursuit). This perception of being a member of the middle class through their engagement with music was likely crucial in supporting their intentions to pursue a

degree and a career in science—neither of which have been highly correlated with working-class goals (Lucey et al. 2003). Becoming middle class through their own agency provided participants with a way in which they could fit in, even though they continued to stand out in other ways. That the participants continued to participate in music throughout secondary school, college, and university, whilst never considering it a possible career path, suggested that they wanted to reap the personal/social benefits musical groups provided. By engaging in the group and performing as a musician, the participants found a discursive moment in which they were considered a part of the norm. Having had this experience, the participants were (unconsciously) familiar with leveraging their own capital to progress in a discursive system. They used similar tactics to apply their science capital in a different discursive formation: physics. Without their participation in musical groups, the participants might not have chosen to participate in physics or persisted towards a degree.

9.8 The Working-Class Hero

Of the six participants, five self-identified as being working class, whilst the last described her grandparents as working class. None of the participants grew up with parents who had a university degree, and most described the world of academia as idealised in the notion of Oxbridge, which their parents and community considered alien to them:

Eve: I mean, I think we were probably a family that was, it was a fairly working class background, you know ... I remember someone got into Oxford who they happened to know and it was considered absolutely amazing, that Oxford was somewhere outside of the universe. Yeah, so, no. It never occurred to anyone that I was going to be anything but a, I guess a teacher, probably. A maths teacher.

Most of the participants equated science with Oxbridge, noting that both were normatively outside the realm of consideration for their families and schools. Further, all of the participants noted that they were amongst the first pupils at their schools to apply to Oxbridge or other Russell Group¹ universities:

Beth: But, I guess I looked at Cambridge because in my sixth form college where they didn't really send very many people to [Oxbridge], they'd had more success with Cambridge, so they were like we don't really know any better, but more people seem to have got into Cambridge so maybe apply there.

Whilst one could be a success in academic physics if one earned an undergraduate degree from a non-Russell Group university, it does seem pertinent that all of the respondents attended Russell Group universities and most worked in them for their entire careers. Their affiliation with these universities seems to have added to their legitimacy and esteem, and yet, they began their association with

¹ The Russell Group Universities are a collective of 24 public research universities in the UK, arguably regarded as the best universities in the UK (<https://russellgroup.ac.uk>)

Oxbridge—coming from, what the participants described as, a minority group of working-class students. Moreover, they described the difficulties their parents had in finding funds to pay for their tuition, typically noting, “I mean we were never flush, but if it was for education we would do it” (Beth). The participants were never asked about class, but spontaneously referred to it when they constructed their background narratives, using specific details (such as scholarships, etc.) to highlight their disadvantages.

It could be argued that the participants’ gendered identity was, on the surface, an inherent disadvantage to achieving success in academic physics, but the participants chose to emphasise their intersection between gender and class. The participants’ perception of being doubly marginalised from the norm of physics (male and middle-class) created a narrative which made them seem especially exceptional and almost heroic: Coming from almost nothing, they had used their intellect and determination to succeed where few people like them ever had. The drama of this trope created a compelling narrative for the participants, a *Bildungsroman* of a sort, that allowed for more insight into their current gendered identities and their desire to break away from the working class. The participants clearly tried to perform a middle-class masculinity, performing intelligence, determination, and aspirations towards academic positions, for example, whilst suppressing yet maintaining their working-class femininity. In performing a middle-class masculinity, the participants shied away from laddish behaviours, and endeavoured to (re)create themselves based on middle-class masculine stereotypes about physicists. However, in addition to retaining ideas from childhood of women being mothers, the participants also struggled with working-class conceptions of women as mothers and housewives.

Through their non-verbal communications, the participants indicated with grimaces and defensive gestures that they were conflicted about marriage and motherhood and the expectations placed upon them by their backgrounds:

Diane: ... because of the way society was constructed at that time. I mean, I’ve already alluded to the fact that married women didn’t work, but *mothers* didn’t work because it was proven that if they did, their kid would be delinquent. So I was actually quite remiss putting him in care one day a month. (laughing)

As stated previously, half of the participants had divorced their first husbands, and their new partners were middle class. For participants like Diane, their childcare regime and position in the household changed dramatically with their change in partner, resulting in a more egalitarian state in which both partners took responsibility for the child. The participants indicated that they were happier with the newer childcare situation and attributed it to their partner’s class.

By performing a middle-class masculinity, and suppressing their working-class femininity, the participants gained the agency to pursue a degree and career in academic physics. However, the gendered identity negotiations through which they laboured were difficult and disruptive. Through this study the participants recreated themselves as working-class heroes (even though they no longer had ties to the working class). Their identity work revealed both the struggles they endured and their passion to succeed.

9.9 Discussion and Conclusions

Determining why gender inequality endures in physics, and what can be done to ameliorate the situation, is a complex task. The research presented in this chapter approaches the chronic issue of gender equity in physics from a new perspective, by exploring the professional and personal pathways of some of the most successful female-identifying physicists in the UK and finding similarities between them. Firstly, the research revealed that participants developed a strong sense of self-reliance in their early experiences with isolation that allowed them to make their own educational choices, and to be less concerned with the opinion of others. Secondly, the participants' engagement in religious and musical support networks provided them with alternative ideologies to peer-enforced social ideologies. These networks reinforced the participants' desires to participate in physics and gave them the opportunity to fit into these contexts. Lastly, the participants (re)created themselves as working-class heroes, a process that acknowledged the intense identity work they struggled through in order to become who they are today.

All of their experiences and coping mechanisms provided insight into how they have become successful, and what might be done to widen participation for women in physics in the future. Similarities in their experiences provided insight into how women's participation and persistence in physics might be increased: through programs focusing on improving self-confidence and self-efficacy; by providing support networks; and in increasing and mandating workshops on unconscious bias and discrimination for all students, whilst maintaining positive actions for those identifying as female. In addition, the current system for promoting and awarding honours and distinctions appears to be meritocratic, which suited the participants. However, it might be more equitable in the future to standardise rewards, so that more women will apply and be awarded honours. For example, applying for the position of Professor might be more equitable if all faculty were required to do so after: (a) working in the field for a certain number of years; and (b) publishing a certain number of articles and book chapters. Whilst the participants in this study were able to achieve a certain normality within their departments, and were, therefore, recognised as physicists by their colleagues (and then nominated for promotions) it might be helpful for others to have a definitive checklist that would showcase their merit.

The participants in this study revealed that social mobility is possible through participation and persistence in academic physics. It may be useful to share these women's stories with working-class students to promote them as role models. Being aware that so many of the most successful women in UK academic physics are from working-class backgrounds may inspire working-class students to participate in physics.

Even though the above analysis discussed how performing masculinity helped the participants to persist in physics, it would be erroneous to presume that these findings indicate a need for those physicists identifying as female to shift their identity or perform exclusively as masculine. It is more the case that gender hybridity

(Danielsson 2014; Lucey et al. 2003), heteroglossia (Francis 2012), or identifying along the gender spectrum, should be recognised as the norm in physics. Thus far, achieving success has meant that those identifying or identified as women were required to negotiate their identities in order to fit in and garner the esteem they needed to receive grants and awards. However, broader non-dichotomous identity expectations in academic physics might be more effective in helping future generations to persist and find their own successes.

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