

Eleanor S. Armstrong & Anna T. Danielsson

Science Butch Blues



Eleanor S. Armstrong is a science and technology studies scholar. Armstrong works on the cultural dimensions of science communication about physical sciences and technology with a focus on outer space. Her research works to challenge narrow, exclusionary conceptions of outer space specifically and physical sciences more generally presented in science communication, towards socially just and equitable futures.



Anna T. Danielsson is a science education scholar. Her research is focused on gender, identity, and power in the context of teaching and learning science. She is particularly interested in process of in(ex)clusion in higher education physics, and her work seeks to illuminate and challenge exclusionary practices in this discipline.

Part 1: Visibility, Gender Identities and Sexualities

Research on science identities is in transition - from understanding men/boys and women/girls who are encouraged or supported to make identities in relation to science, to thinking about the constructions of gender through masculinities and femininities that are (or can be) aligned with science (Danielsson et al. 2023a). The move is currently partial. Femininities (or, sometimes in the literature, femininity) have not been fully decoupled from women and girls, nor masculinities (or masculinity) from men or boys. Motivated by recognition that gender is a social performance, science identity literature is working towards a queerer vision of who can participate in science and how (Fifield & Letts, 2019). Here, we extend this inclusion by making visible butch science identities and argue that attending properly to the place of queer identities in science identities research enriches the field as much as it recognises butch identities in STEM.

We respond to the call for the issue by thinking about what acts of epistemic diversity can be found in foregrounding butch science identities, as well as what kinds of theoretical and methodological innovations that are made possible by including female masculinities in science identities research. We aim to “camp up heteronormative knowledges and institutions” (Sullivan, 2003, p.vi) of science by making visible butches and their participation in science. As we show in the next section, the current constructions of genders through masculinities and femininities in science identity research work to

make butches invisible, tidying away both their role in science and ways that science makes their identities possible. We then show a selection of examples of the multiple possibilities of butch science identities from literature, film, personal memoir. The contribution then foregrounds how a research focus on butch identities opens what we describe as a queer epistemology of the science butch, and decrobes what this makes possible within science and technology studies on identities.

In this paper, we build from the work of educators and scholars who are broadening participation in STEM fields among students minoritized by race, gender, and/or sexuality (McNeill et al. 2022). We expound on how research on science identities is characterized in the following section, but we note here that research on which (gendered, racialised) identities are supported and confirmed in and through participation in science is currently a central concern of sociology of science education. Decoupling gender and bodies in relation to technoscience has allowed us to theorize about “how discourses of masculinity and femininity afford and constrain the positions available to the women [and men] students” (Danielsson & Lundin, 2014). We see call in text such as that by Lucy Avraamidou (2020), who urges greater focus on the heterogeneous performances of gender in science identities by individuals; and in Eleanor Armstrong’s (2023) argument that encourages queering how we read science objects through gendered lenses, rather than projecting genders onto bodies who use scientific objects. While research on LGBTQ+ identities in science (especially focused on scholars and professionals in STEM) has some tradition, a move to think *queerly* about science identity is, in our reading, still not here (Muñoz, 2019). We are oriented, then, to the futurity of the field: we both invoke and speak to the there and then of queer science identities. We think with Swirtz and Barthelemy (2022), who advocate for a queering of methods in physics education research, and extend this into thinking about how making visible queer identities opens new methodological possibilities in science education research. Equally, we think with Marosi, Avraamidou and Lopez (2022) who identify how research on the experience of LGBTQ+ folks in professional science are multivalent: illuminating cultures of science, the experiences of queer folk in STEM, and the mechanisms individuals use to continue in these fields to think about the plurality of perspectives that a focus on butch identity might bring to science identity research. In the spirit of queer theory’s call for rejecting a pragmatic approach to research in capturing what exists, we will instead, here, be *doing the future* we hope to bring into being - rejecting the heteronormative status quo and opening the cracks and fissures in the established knowledge systems as a call to action for such work in science identity research.

We write as scholars in science education and science and technology studies. We take inspiration from Stacy Holman Jones and Tony E. Adams *Autoethnography as Queer Method*, who argue that subjugated knowledges (including pleasure, intimacy, gratification), subjectivities, and the recognition of queer colleagues gives us expanded ways

into understanding the experiences of the world around us. Thus, we reflect here on our own positions and motivations in relation to both butch identities and science identities for this piece. Epistemically, the text is motivated by both authors having parallel interests in gender/queer studies and science identity research; and our desire to see these fields brought together. Each of us has worked to unite these themes in their own work and we here continue this together. Likewise, we are united as having previously been queer researchers in science, not seeing these identities as well captured or well understood in research literature. Particularly, our own experiences encourage us to think about geographies and temporalities of queer identities in this work. Our trajectories have been in transnational Euroamerican research – a geography which is certainly reflected in the literatures and ideas we have included in this piece. One of us sees butch identity as something she moves into and out of depending on the spaces they are in; the other had a tomboy childhood, which gave her a recognisable science identity growing up. Through our own trajectory through social class and moving national contexts; we note our experiences of butch identity and other queer identities are inflected by our class, scholarly professions, and geographical contexts. Throughout this text we write with a plural pronoun to represent our thinking in concert with each other, and our solidarity of ideas, that developed this text.

Before departing into the remainder of this text, we ask: *what is* and *who inhabits* a butch identity¹? Sherrie Inness and Michele Lloyd (1996, p.14) characterize the butch as “a lesbian who adopts masculine identifiers”. However, while this characterisation is seductively simple and captures important aspects of butchness, the queer potentiality of the term remains unfulfilled with this description. Jack Halberstam expounds:

The butch is neither cis-gender nor simply transgender, the butch is a bodily cat-achresis. The Greek word, catachresis, means the rhetorical practice of misnaming something for which there would otherwise be no word. Butch is always a misnomer - not male, not female, masculine but not male, female but not feminine, the term serves as a placeholder for the un-assimilable, for that which remains indefinable or unspeakable within the many identifications that we make and that we claim. (2018, p. xx)

The butch, Halberstam (2018) continues to argue, may by some be assumed to be an old-fashioned form of identification, at the risk of disappearing into other transgender identities. Yet, they refuse to slip into anachronism or to be easily positioned on a cis/trans-continuum. In many ways, the queerness of the butch lies exactly here, in their refusal to be easily pinned down or defined. Hence, a butch performance of masculinity has subversive potential in how it plays with and re-creates a male masculinity, without

¹ Throughout the text we use the pronoun they to characterize ‘butch’ in general as a figurative group rather than an individual in recognition that the gender performance is not inherently tied to female bodies. Where individuals have referred to themselves with a particular pronoun, we follow this self description.

simply reproducing it. As Levitt and Hiestand (2004) argue, butch lesbians take elements of masculine gender presentations, behaviors, or attitudes unevenly and do not reproduce them uniformly in all contexts. As much as any other identity, butch identity is stereotyped - elements of which are variously embraced or rejected by butches themselves. These include the expectations to be:

“to be tough, to be a leader, to take care of and protect others, not to cry, not to date other butches, to be sexually dominant, and to take care of chores designated as men’s responsibilities” (Levitt & Hiestand, 2004, p. 612)

This can be seen in literature, butchness is portrayed as played out through mannerisms and behaviors as well as clothing, appearance, interests, and desires. S. Bear Bergman (2010), in hir auto-biographical short stories, narrates a gentleman butchness, a civil and refined version of masculinity, deliberately distanced from violence and misogyny. Attributes such as white shirts and cufflinks signal a meticulously crafted gender expression. The gentleman butch is courteous and caring, always prepared to help and carries the tools to do so. Bergman is an author and a performer, but the skills of hir hands are woven through the stories, as a badge of masculinity in all its complexity:

They are hands that capably wist jars open, twist wires around contact points, twist nails out of wood, but also hold her so gentle, soft enough to cradle a newborn between them safely against my heart, pick a dock splinter out of a smooth thigh; steady enough to make pleasure between, to hold hopes between (2010, p. 99).

The character of the protagonist in Judith Frank’s (2004) novel *Cry Baby Butch*, about a complicated relationship between two butches from different generations, is braided around practical and mechanical skills. With a low level of reading ability, Chris is able to support herself and her partner through a relatively well-paid job as a plumber. This working-class version of butchness resonates with the portrayal of Jess in *Stone Butch Blues* (Feinberg, 2003), who finds comradeship with fellow butches in factory work and at local bars. Butch identity has longstanding connections to working class communities, and navigating class tensions and dichotomies between blue collar and white collar work environments is a rich field of discourse and scholarship. As with many discussions about class position, this identity work is also racialised and intersects with religion and disability (see, for example, Clare, 2013; Maulod, 2021; Moore, 2006) with individualized subcultures that have different norms, expectations, and performances within them. Just as butch identity is stereotyped like many other gender identities, it is also like many other identities not-monolithic, and contains a rich plurality of possibilities.

Constructions of butch - but importantly not all butch identities - are crafted in relation to femmeness (a lesbian pronounced femininity). While some have constructed butch/femme dynamics as subversion of the heterosexual matrix (Halberstam, 2018,

Laporte, 1992), others argue that expectations about ‘legitimate’ pairings are carried over into queer relationships making them legible within a heterosexual matrix but also bringing with them elements of patriarchal and misogynistic social expectations. Elsewhere, queer relationships of butch/butch or femme/femme subvert quasi-heterosexual expectations in relationships in different ways, offering many possible ways of making relations (Walker et al. 2012). Finally, we note that whether butchness is expressed through a gentleman behavior, through a tough masculine appearance, through the skills of the hands, or desire there is no correct butch, ‘the dapper butch engineering professor’ is likely to raise fascination more than fear, while still pushing back on hegemonic notions of gender.

Part 2: Gender, Masculinities, and Science

Boys are brought up in big trucks! And tractors! Once you drive a car, you want a big fast thing! You know. If that’s your kind of THING, well, then you’re actually going to be pulled in to plasma physics! ‘Cause there’s some REALLY HIGH POWER, SEXY, EXOTIC EQUIPMENT IN THERE! (Pettersson, 2011, p. 55)

The quote above comes from one of the scientists in Helena Pettersson’s (2011) anthropological fieldwork with plasma physicists, illustrating the perceived connection between this subfield of physics and a technical masculinity, assumed to appeal to boys. Further, there is a strong passionate relationship between the physicist and the experimental equipment, one that has been nurtured since childhood. The physicist community described by Pettersson (2011) and earlier in a similar environment by Sharon Traweek (1988) is one characterised by homosociality, where younger generations of researchers are inducted into a masculine scientific culture. Erika Lorraine Milam and Robert A. Nye (2015) trace such masculine scientific cultures historically and argue that the reproduction of these is also aided by men’s experiences in all-male environments in sport, school, and the military. Yet, the gaze of researchers exploring science and gender has predominantly been turned towards women and women’s under-representation in science.

Already in 1918 Harold Lyon was investigating how interested boys and girls were in various science related content areas. While we have come a long way in terms of theorizing both science, gender, and education since Lyon wrote his paper, the lingering uneven participation of men and women in mathematics intensive STEM-disciplines still motivates a large number of studies concerning gender and science education. A recent review by Anna Danielsson, Lucy Avraamidou, and Allison Gonsalves of such research shows that the field is still dominated by studies of sex-based differences regarding achievement, interests, attitudes, and participation (Danielsson et al., 2023b). However, there is also a growing number of studies concerned with students’ identity formation and sense of belonging in the sciences, particularly highlighting the identity

negotiations necessary for many women in order to fit into masculinity connotated science disciplines such as work by Spela Godec (2018). Such studies have given valuable insights into how women negotiate gender in relation to the culture of physics, showcasing, for example, how women in physics moderate dress and appearance (Ong, 2005, Gonsalves, 2014) and how they emphasize the value of skills and characteristics typically associated with women (such communication skills or small dexterous hands (Gonsalves, 2014)). The studies also bring to the fore how the masculinity of physics is not only connected to the proportion of men in the discipline and symbolic connotations of the discipline, but sometimes also built into the actual experimental equipment, making it difficult to handle for small-framed women (and men) (Gonsalves, 2014)).

There are also several studies highlighting women in STEM positioning themselves as ‘one of the boys’ (Danielsson 2012, Madsen et al. 2015). Recognising the limits of work focused on girls’/women’s participation in and relation to science and acknowledging that not all boys/men, particularly those from minoritised backgrounds, experience a sense of belonging in science a growing literature is looking into the relationship between boys/men and science learning (Archer et al. 2014, Archer et al. 2016, Carlone et al. 2014, Carlone et al. 2015, Stahl et al. 2021). Among other things, this research has demonstrated how class and ethnicity play into boys’ science engagement, making it easier for middle-class boys from White and South-east Asian backgrounds to identify with science. While the intersections of class, race, are beginning to be unpacked in relation to hegemonic gender identities, subversive performances (e.g. the tomboy) are often implicitly racialised as white, and nuance about class and race is absent from discussions.

In literature about masculinities in primary and secondary science schooling, the doing of masculinity holds an ambivalent position. On the one hand, the masculine connotations of science makes some boyhood masculinities easily combined with science (Carlone et al. 2015). On the other hand, there are tensions between, for example, more boisterous masculinities and schooling in general, meaning boys from working-class background and some ethnic minority backgrounds are less likely to pursue science (Archer, DeWitt & Willis 2014). As such, there is a continuity from respectable and/or geeky boyhood masculinities to adult engagement of men in STEM. A boy’s childhood playful enactment of science and/or technology can also extend into adulthood: Ulf Mellström (1999) argues that technology in this way offers a world of ‘eternal youth’. The tomboy - a kind of girlhood masculinity we expand on later - may also find a place in school science (Archer et al. 2012; Knaier 2019), but this is an identity a girl is largely expected to grow out of.

One of the notable appearances of masculinities not tied explicitly to men in existing science identities research literature is in a 2011 study of heteronormativity in engineering education, where in discussion about heteronormative assumptions about skill, two

respondents describe their perception that, because STEM is inherently seen as masculine, a masculine-presenting woman is more likely to fit in:

I guess there's this assumption that, 'oh, you're a lesbian, you're kind of butch, you are definitely kind of more guy-ish, so it would make sense that you are an engineer, because guys are engineers' ... I think, for straight women, it's like, 'oh, you're pretty, you would want a social type of major.' ... Because I'm not a stereotypical female, it's ok for me to be an engineer. I'm smart enough, I'm able enough. I do think people see lesbians in engineering as more capable than straight women ... [For] gay men, I think it's the opposite. They're seen as more incapable than straight men. (Becky, lesbian woman undergrad) (participant data quoted in Cech and Waidzunus, 2011, p.12)

In this quote a chain of articulation is created where lesbianism is associated to masculinity, which in turn is associated to engineering - and thereby allows for the lesbian engineer to inhabit a position as 'one of the boys'. A very similar argument is made by another participant in the same study:

I mean, queer women are already seen as being more masculine than straight women, in some sense they are seen as more manly, and so that squares more with the 'manly' field they're working in. (Eric) (participant data, quoted in Cech and Waidzunus, 2011, p.12)

The assumption, then, is that people who present in a more masculine way have an easier time fitting into STEM fields with masculine connotations, but still not sufficiently to get 'proper' recognition by men in STEM spaces. Where some research shows butches are more likely to see validation in Silicon Valley companies (Alfrey & Twine, 2017), other research shows masculine presenting women are more likely to experience backlash in their careers in STEM (Kersey & Voigt, 2020).

As valuable as this science identities research has been in terms of moving the conversation from a binary and static conceptualisation of men and women as two distinct groups that engage with science in different ways to a more pluralistic view of a range of different femininities and masculinities, there are a couple of things that are chafing for us. Andreas Ottemo (2015) argues there is a strong case to be made for the intimate connection in the Western world between masculinity and values that are central to science, such as objectivity, rationality, and control over nature. But, Ottemo (2015) continues, there is a danger in too quickly assuming that this symbolic gendering of science also holds for socially produced femininities and masculinities in a particular context. It is all too easy to fall into the trap that "technology [or, science, our remark] is masculine because men do it" (Wajcman, 1991, p. 24). Not only does this logic couple masculinity to science/technology, by assuming that what men do is masculinity, it also disregards the possibility of women doing masculinities (and, by extension, men doing femininities).

As such, the physicist woman who positions herself as ‘one of the boys’ becomes an anomaly, someone who is simultaneously failing at doing “womanhood” and doing “masculinity”. It assumes that taking up a position as ‘one of the boys’ is something women need to do in order to fit into a man-dominated STEM-discipline (Madsen et al., 2015) or as something (some) women are passively socialized into (Gonsalves 2014). That is, women and men are assumed to neatly fit into a heterosexual matrix, desiring to be feminine and masculine, respectively. The narrative of a woman struggling to succeed in an area traditionally dominated by men such as science can be understood as a way of engaging in making visible power dynamics; and we see the same questions make visible about power and identity through the desire and actions of enacting female masculinities in science arenas.

Further, while recruitment of more women to the mathematics intense STEM-fields is an often recurring rhetoric, the desired woman in policy speech and widening participation campaigns is one that is able to present a respectable hetero-femininity (very acutely illustrated by the high criticized campaign ‘Science: it’s a girl thing’, launched by The European Commission in 2012). Natalay Chesky and Rebecca Goldstein (2018) highlight how ‘the composite nature of many images associated with girls and STEM reinforce gender-normative and hetero-patriarchal assumptions’ (p. 98). As a consequence, the butch scientist may on the one hand be at the risk of not being seen as masculine enough for science, given the strength of the chain of articulation men-masculinity-STEM, but also does not fulfill the kind of ‘womanhood’ or femininity that programmes devoted to more women in STEM seeks. In physics in particular, the field’s self-construction of ‘gender neutrality’ can render the butch physicist invisible. By adhering to a norm of appearance of physics that are perceived as neutral, gaining strength from how masculinity typically is perceived as non-performative - something that just is (Halberstam, 2019) - the butch may not be recognised as subverting norms of femininity or masculinity but read as someone that just puts the discipline-appropriate, minimal consideration to their dress and appearance. Ottemo et al. (2021, p. 1029) argue: ‘Caring about style and appearance simultaneously signifies femininity and not caring about or being passionate enough about physics’. Thus, paying too much attention to style and corporeal aesthetics is an action that undermines the potential to be recognised as passionate about one’s discipline. They further argue that the rejection of the body is central to making physics appear as a discipline where only the mind matters. As such, the butch physicist can blend into a geeky and non-sexualised physicist ideal, which is mediated as outside of sexuality and gender.

Part 3: Collaging butches in science outside of straight time.

In this section we have collaged a series of short extracts from a selection of different (but largely western) contexts, media, and periods, to give a flavor for the different ways that butch and science identities are constructed in conjunction, read as coincident, and

co-created for individuals. These are neither exhaustive nor fully representative, and are here to orient the reader to our theorizing in addition to the data included elsewhere in this text.

“I wanted to see if the Science Museum had a souvenir shop that sold rocks and crystals. I’d never been to the Museum before. A giant stuffed buffalo stared at me as I walked in. The space felt still and quiet inside the building...I wanted to spend the day there. Each room off the huge centre hall was devoted to a different branch of science. One was named the Hall of Man--it turned out to include women, too. There were rooms that revealed the secrets of atoms, of universes.

I wished I could stay and devour all that knowledge. I hoped somehow it would make sense of the world to me. But I could feel my bladder begin to ache, and the two bathrooms were in plain sight of the woman behind the souvenir counter. I just couldn't deal with it. I left the secrets of the universe behind, got back in the car, and drove to Gloria's house to use the bathroom in privacy.”
(Stone Butch Blues, Leslie Feinberg, p. 161)



Figure 1 Screenshot from the r/butchlesbians subreddit in a thread asking if there are butch scientists. Taken by the authors, 2 June 2023, at https://www.reddit.com/r/butchlesbians/comments/11x6fet/any_butches_in_maledominated_fields/

“A rather masculine lesbian friend of mine, who does not identify as butch but, as she puts it, always knew she was gay, teased me one day, “If you are so butch, where is your tool belt?” When I have practical problems in my Florida home, I call her. In fact, she built the desk on which I am writing. But her father was a mechanic while mine was a psychologist who never wore a tool belt or fixed anything. Postmodern butch is not necessarily about tool belts or who is more dominant in a relationship; it is not even about what you do in bed (or elsewhere). It is about a gender expression that combines some version of the masculinity that you saw around you as a child with same-sex desire...At forty-one, then, I claimed this butch identity because it made sense of my sexual and personal experience and because, to paraphrase Stuart Hall, to claim an identity is to place oneself in a narrative of history.” (My Butch Career, Esther Newton, p.4-5).



Figure 2 Animated character from *Chicken Run* (Lord and Park, 2000) of ‘Mac’. In the movie she demonstrates technical skills through planning the machines and contraptions used to engineer the chickens’ escape.

Lily spooned up another bite and let it dissolve slowly on her tongue before responding. “I wish there was a girls’ science club or something. I suppose we could join the regular science club, but it’s all boys, I wouldn’t want to be the only girl.”

(Last Night at the Telegraph Club, Malinda Lo, p.99)



Figure 3 Rowan, a character in the webtoon *Girls School of Knighthood*. Depicted here with a chemistry belt and glasses to protect her eyes while doing experiments, Rowan is described as “Ruthlessly committed to perfecting the ideal smoke bomb alongside her other biochemical warfare experiments as a student knight, Rowan’s caustic personality and penchant for causing chaos often lands her in trouble.” Image shared with permission of the creator (Mead, no date), 20 June 2023. Full cartoon available at: https://www.webtoons.com/en/challenge/girls-school-of-knighthood-gl/list?title_no=373799&page=6

Part 4: Queer epistemology of the Science Butch

What could the inclusion of butch identity in STEM practice, policy, and research do to our understanding of the richness of gender identities in STEM fields? Drawing on José Muñoz’s queer horizons, we here develop a queer epistemology of the science butch. A queer epistemology acknowledges that queer theory does not simply focus on sexual or erotic spaces in our society, but rather questions about epistemology of spaces, social priorities, and possibilities. We show the potential for this to open new ideas in identity-led research on science identity and science cultures: (i) we look at the technical skill and interplays with infrastructure that characterizes butchness as an integral component of STEM identity; (ii) we think about complicating the static nature of science identities temporally through the interplay and tensions of tomboys and butches; and (iii) we show that understanding butch identity compels pluralisation of masculinities and feminities. In this section we explicate some of the practical and methodological implications and potentials of the queer epistemology of the science butch.

From the descriptions of butches in literature, media, and memoir - a selection of which we have included above - we note that butch identity is frequently co-constructed with technical skill and in interrelation with the infrastructure that surrounds them. Particularly obvious is the characterisation of technical maintenance of machines. In the examples above, elsewhere in *Stone Butch Blues* Jess’ work in mechanical parts of factories and their care of motorcycles are ways of demonstrating a butch identity in fiction. Similarly,

Esther Newtons' participation in motorcycle hobbies is writ large through the memoir we have shared an extract from here. Through her development of the plane that lifts other chickens from the coup, Mac's technical skill is a central feature of the plot of *Chicken Run* - and her butch representation of a masculinity presentation (with similar accessories and arrangement of feathers on her head that echoes those of the roosters in the movie) sets her apart from other hens in the movie, all of whom are characterized as working class proletariat under the class-struggle narrative arch. Where mechanical skill has long offered potential "technology masculinities," in science identity research, we argue that the field overlooks technological female masculinities (particularly in working class mechanical contexts) - a genre of skills and techniques that open the associations of masculinities with other bodies, in particular butches. Theoretically this offers a way of pluralising the types of masculinities that are understood in relation to technology. Hegemonic technological masculinities theorizes men engaged in technology as a space of prolonged youth for boys and men, what might attention to technological masculinities of butches bring to science identity research? Our queer epistemology of the science butch identities directs attention to the spaces where technical and mechanical skill are important like the mechanical workshop, trade education, or hobby-mechanical work, but perhaps are not always conceptualized as spaces for STEM skill development. Methodologically, then, this asks science education scholars to queer where they could be looking to capture practices of STEM; as well as the kinds of research instruments that might be needed to capture STEM skills beyond those traditionally thought of as 'science'. Incorporating masculinity studies in their research, this tension around the fit of bodies and mechanical skill has been described by Allison Gonsalves, Anna Danielsson, and Helena Pettersson (2016); the research takes place in physics workspaces and laboratories. What would similar work in more expansively conceived STEM locations offer the research discourse?

Beyond this direction to look towards plural scientific contexts for science identities, we also call attention to how this epistemology argues for paying close attention to the way science (learning) infrastructures shape participation. We see this particularly in the quote from *Stone Butch Blues* where it is the need to depart to use the toilet that is a push for Jess not to engage in learning at the museum. Jess' experience is fictional, but certainly not at odds with the way queer communities have and do experience science spaces (see, for example, Armstrong & Lock, 2023). While in previous scholarship by Allison Gonsalves (2014) grapples with the ways women narrate their interactions with the scientific objects of research in their training; we suggest that the queer epistemology of the science butch asks us to take a more expansive methodological view to capture the interactions with the physical, built environments of science, the journeys and routes that are required for queer folk to access them; and their (in)hospitality to queer bodies and selves.

A queer epistemology of the science butch also opens questions about temporalities of science identities. We begin this by looking to the literature on tomboys. The tomboy in existing science identity studies, as described in Part 2, is constructed as a childhood identity. Theorized as a complex arrangement of relations to femininities and masculinities; highly situated in cultural and historical contexts; tomboys are often discursively constructed in relation to their skill and competency as much as gender presentation. The tomboy, understood as a gender identity, has an intricately formulated and not uniformly interpolated relationship with sexuality – which runs the range of being an de-sexualised childhood, to a covert heterosexuality, to a proto-queer adult. The tomboy is also primarily conceptualized as a white identity (Craig and LaCroix, 2011). Halberstam, in *Female Masculinities*, describes the tomboy as an “extended childhood period of female masculinity” (Halberstam, 1998, p. 5) – distinct from butch female masculinities but overlapping in characteristics. For Halberstam, both identities share a similar rejection of the cisheteosexualising gaze, have similar style of gender performance, and similar attributed skills.

Appearing throughout scholarship on primary schools (Paechter and Clarke, 2007; Paechter, 2010), tomboys are understood by adults and children alike in opposition to girly-girls who, it has been argued, stands in as a precursor to emphasized femininities in adulthood (Connell, 1987). In their 2011 paper *Tomboy as a protective identity* Traci Craig and Jessica LaCroix further position the tomboy as an identity that can be inhabited in ways that are cautionary for the individual - protecting sexual reputation, protecting sexual orientations, allowing interlocutors to use “a tomboy identity to explain masculine appearances and activity preferences” (2011, p. 453). While often set in opposition, it is important to note that both the girly-girl and the tomboy sit in relation to a range of other gender identities in childhood (Raey, 2010). It is common (arguably, even celebrated in the literature about science education) to see the tomboy in science identity developed in girlhood, as we have described in Part 2. Tomboys offer a way of being part of science domains which are continuously re-inscribed as highly masculinised. Thus, the presence of the tomboy in science identity literature echoes that which happens elsewhere, namely the:

[a]cceptance of tomboys into masculine domains is to make an exception to gender binary rules but ultimately allow the binary gender system to remain intact (Craig and LaCroix, 2010, p. 462).

But, as we follow literature that grapples with primary, secondary, and higher education; we cannot follow the tomboy through into their young adolescence or early adulthoods in science identity research. What happens to these tomboys? Where are they by later secondary education, or higher education? Moreover, we find that their counterpart butches often absent in the literature for youth or higher education. Female masculinities as viable science identities seem to be dropped, dismissed and discredited as the

youth who are the subject of science identity research age out of periods of ‘acceptable’ childhood tomboyhood.

We think with existing research on queer girlhoods beyond science identity research, and look to the ways in which this both suggests methodological shifts and theoretical reorientations to build our queer epistemology of the science butch. In her introduction to *Girlhood Studies*, Barbara Jane Brickman (2019) asks the reader to think through how rejecting heteronormative girlhood and brining the queer girl into the center of research opens the potential for “the queer girl [to effect] a redefinition of girlhood itself” in response to Marnina Gonick’s (2006, p. 122) provocative question “Are queer girls, girls?” We advocate for a version of science identity research that thinks in tandem with work being done to displace “the enduring centrality of a white, able-bodied, Western heteronormative girlhood [that] continues to plague critical work on girls and girl cultures” (Brickman, 2019), and instead takes seriously queer girlhoods in and of themselves. The tensions for the queer girlhoods of the tomboy are particularly apparent. Theorizing on depictions of tomboys in literature, Shawna McDermott notes how:

Time and time again, authors choose to give their tomboys dreams beyond what their gender will allow, and then they shatter those dreams in order to demonstrate that they were not the correct ambitions and should be replaced with the joys and benefits of traditional womanhood. The ideal of the tomboy who persists untamed is, according to this tradition, impossible, an enigma, an oxymoron, not to be realized (McDermott, 2019, p. 135)

Read in parallel with the discursive ‘dropping’ of the tomboy in science identity research, we see McDermott’s description of the expectation that one grows out of being a tomboy in literary canon echoed in the fleeting characterisation of tomboys as a successful science identity. In *Happy Objects* Sara Ahmed (2010) argues that queer desire is in part to be oriented incorrectly to gender identities and their objects of happiness, such as marriage and family. Thus we ask, can we characterize the seemingly-misplaced happiness, joy, and benefits of being aligned with participation in science of the tomboy as yet merely another dream to be shattered, replaced with new ‘correct’ objects of happiness that better aligned with traditional femininities as the tomboy ages?

Seeing the tomboy in relation to butches, our framing opens new ways of challenging the expectation that one grows out of tomboyhood. By embracing a queerer childhood that sees children outside of heteronormative space and time, where children can subvert expected norms and can take up other positions and ways of performing, our queer epistemology of the science butch subverts expectations of taming of queer ambition as the child grows older. We also argue that rejecting the paradigm of the tomboy as exclusively an acceptable way of making a meaningful identity in and in relation to sci-

ence in childhood can also be productive engagement in thinking with a queer epistemology of the science butch. We look to theorizing of queer temporalities to ask: what other temporalities might there be for the tomboy? Resisting capitulating to the acceptability of the tomboy's gender-sexuality matrix in relation to hetero-normative womanhood as being condoned "as long as she eventually grows out of it" (Craig & LaCroix, 2010, p. 453), how might we think of tomboy adults or butches (as described and documented in Halberstam, 1998) as an adulthood science identity too? These framings offer new ways of thinking about actions and theorizing towards inclusion in science identity practice and policy.

Through a queer epistemology of the science butch, and with Halberstam (1998, p. 8), we "refuse the futility of the tomboy narrative and instead [seize] on the opportunity to recognise and ratify differently gendered bodies and subjectivities." Notably, in *Last Night at the Telegraph Club*, quoted above in Part 3, the young queer character's tomboyish adolescence strongly characterized by participation in physics and mathematics, is transmuted into a butch young womanhood which continues to be linked to working in science at the end of the book.

How, instead, might understanding the potentials of transitional moments between temporal female masculinities allow us to grapple with queer futurities of research participants and transitional moments within the lives of young people? We can look to queer theorists of childhood to understand this. Kathryn Bond Stockton's (2009) theorizing of the queer child 'growing sideways' as a defiance of expected 'growing up' – demonstrating a rejection of reproductive subjectification – might offer science identity research theoretical tools to grapple with participation in science that is not towards instrumentalist ends in an adult future.

Methodologically, this also opens questions about the mutability of (science) identities between childhood and adulthood, and how to capture this in science identity research. There is a recent turn in the field of science identity research towards longitudinal studies of cohorts of students (see, e.g. Archer, 2014; Danielsson et al. 2023a) where we might see the reshaping of identity. However, the research instruments used over this period bring identity into being through their implementation. Qualitative and quantitative instruments used to capture identity performance in the long term frequently tie femininities-to-women, and masculinities-to-men. This often means they demonstrate the kinds of well rehearsed decline in interest in science of 'girls', without being able to capture the changeable relations of masculinities and femininities that individuals maintain. Invoking the queer epistemology of the science butch, what does it look like - both qualitatively, quantitatively, and ethically – to trace the changing relations between girlhood/childhood-masculinities and adulthood-masculinities? What might doing such work make visible to the research community in science identity? Developing such methodological tools is likely to open new possibilities in understanding the transitional

identities that individuals inhabit during their adolescence, show trajectories of possibilities and bricolages of performances that make possible sustained participation in science.

Our queer epistemology of the science butch also asks us, as researchers, to pluralise our conceptions of masculinities and femininities in science identity research, and further remove them from inherently tying them to sexed bodies. Rather than defaulting to masculinities mapped to male bodies and femininities to female (which, incidentally, leaves researchers in an artificial bind about how to describe the participation of non-binary folk), a focus on butch identities asks us to take seriously female masculinities and, as a consequence, ensure that the ways we describe and work with concepts of masculinities and femininities is inherently pluralised and descriptive of the specific politics of norms, recognition, and identification. We see this, for example, in asking about where the soft butch can be made visible in science identity research. Where too might we see the inverse - the male femininities of the 'sissy' for example? Thus the queer epistemology of the science butch gives us an epistemic orientation to the plurality of possible genders that are made in and in relation to science.

Conclusion

We have argued here that to date science identity research has overlooked non-conventional identities such as butches. We opened this piece making visible butch identity; and going on to describe the existing literature on science identities with specific interest in the types of genders - and particularly the construction of masculinities - that exist within the literature. We then gestured to the descriptions and media engagements with butch science identity to give the reader points of triangulation about the interplay of these two identities. In the final section, we describe our queer epistemology of the science butch, whereby we show how making visible butch identity in science identity work opens a range of theoretical, methodological, and practical implications. These ask us as researchers to take seriously questions about (i) which skills and infrastructures we see as being properly parts of STEM research, (ii) to develop theories about transitional identities and work on the temporal dimensions of minoritised identities, and finally (iii) to take seriously questions of specificities of gender in science identity research.

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