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'Ever yours, mathematically': women's letters and the mathematical imagination

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ABSTRACT

In this paper the author looks at the letters of two renowned women mathematicians and scientists of the Victorian period, Mary Somerville and Ada Lovelace, while also considering the imperceptibility of Sophie Germain, an important French mathematician and philosopher in their epistolary exchanges and philosophical writings. Drawing on the importance of mathematical correspondences and epistolary education in the creation, circulation and dissemination of knowledge, as well as in processes of formal and informal learning, the author argues that Lovelace's and Somerville's letters leave traces of a remarkable genealogical line of women's mentorship and personal relations in the nineteenth century world of British mathematics in the backdrop of contradictory discourses around gender, mathematics, and science education.

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> I shall be very grateful if you will be kind enough the first time you have a few spare moments, to write me a letter about rainbows. *I* am very much interested on the subject just now, but I cannot make out one thing at all, viz: why a rainbow always appears to the spectator to be an arc of a circle. Why is it a curve at all, and why a circle rather than any other curve? I believe I clearly understand *how* it is that the colours are separated, and the different angles which the different colours must make with the original incident ray. I am not sure that I entirely understand the *secondary* rainbow. —
>
> Is the spectator's eye supposed to be in the centre of the circle of which the arc of the rainbow forms a portion? —
>
> Have you read Mrs Somerville's new book, and what do you think of it?[1]

On March 15, 1834, young Ada Byron wrote to her tutor William Frend a letter with questions about rainbows. At the end of the letter, she mentions Mary Somerville's 'new book', *The Connection of the Physical Sciences*, first published in 1834. Somerville was already an acclaimed woman mathematician and popular writer of scientific books, possibly a woman to look up to and admire for young Lovelace,[2] who was nineteen years old at that time. Frend indeed encouraged her to meet and become friendly with Somerville,

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who was in his view 'not more distinguished by her scientific attainments than by her amiable qualities',[3] and this is what eventually happened later in the same month. Lovelace became Somerville's protégée, and they began a life-long friendship and correspondence:

> Ada was much attached to me, and often came to stay with me. […] She always wrote to me for an explanation when she met with any difficulty. Among my papers I lately found many of her notes, asking mathematical questions, Somerville wrote in her *Personal Recollections* (2001, 150).

This paper draws on Ada Lovelace and Mary Somerville's correspondence in looking back at a rare relationship between two renowned women mathematicians and scientists of the Victorian period.

There is an important body of literature around both women mathematicians[4] and although their mentoring relationship has been acknowledged and identified, their letters have not been studied in their interrelationship, although extracts of them have been used in various biographies.[5] It is this gap in the literature that the paper addresses, particularly considering the importance of women's relationship, collaboration and mentorship in science and mathematics in general and women's science education in particular. In this context, Meritxell-Simon Martin has drawn on 'epistolary education' to explore 'the significance of letter-exchanges in acting as informal sources of education for girls and women in English mid-Victorian bourgeois families' (2020, 13), by focusing on the correspondence of Barbara Bodichon (1827–1891), a leading figure in the UK movement for women's higher education. Letters are 'lifelong educational instruments' in Martin's analysis, in an overall take of education as Bildung, 'the life-time process of self-cultivation' (14).

Elsewhere in my work, I have looked at the importance of women's friendships and networks in the movement for women's higher education in the UK (see Tamboukou 2003), as well as in the international movement for women workers' education (Tamboukou 2017), particularly considering the importance of letters, amongst a range of auto/biographical documents.[6] But here it is crucial to note that although scientific networks were important in advancing and supporting the few women who dared to emerge in the world of mathematics in the early modern period and beyond, relations between women mathematicians are very rare to trace.

While considering the importance of the International Federation of University Women (IFUW) in forging and sustaining relations, networks, and personal friendships among university women in the wake of the Great War, Christine Von Oertzen (2014) has looked at the first half of the twentieth century. This paper however, takes a step back focusing on rare networks and relationships of women mathematicians in the Victorian period, thus contributing to an emerging body of literature that examines women's epistolary writing as platforms for the production of scientific knowledge (see George 2011; Schurch 2019). In doing so, it also points to some glaring missed opportunities for women mathematicians to connect across and beyond national borders. What I therefore argue is that excavating such relationships can bring important insights in grappling with women's marginalization in the world of mathematics that reaches our own days, while also making a contribution to the importance of 'epistolary education' (Martin 2020) in the wider field of gender and science education.

The paper emerges from a wider Leverhulme funded research project of writing a feminist genealogy of 'automathographies', a concept denoting the autobiographical desire

of becoming a mathematician, which was coined by Paul Halmos (1985) in his influential book, *I want to be a mathematician: an automathography*.[7] By gendering Halmos' desire, what I argue is that it is essential to throw light onto the social, cultural and political practices that some women mathematicians deployed in surpassing the restrictions and limitations of their gendered position and follow an academic career in the field of mathematical sciences. In thus working genealogically I excavate the archive of Lovelace's and Somerville's letters, which are housed at the Bodleian Libraries in Oxford.

The paper unfolds in four sections. After this introduction, I look at the importance of studying letters and correspondences in a genealogical exploration of the constitution of the female self in mathematics and then I study the correspondence between Somerville and Lovelace in in the early stages of Lovelace's engagement with mathematics. Finally, I consider the role of mathematical imagination in the Lovelace – Somerville correspondence, as well as in the philosophical writings of the English Ada Lovelace and the French Sophie Germain.

Letters and correspondences

Scientific correspondence was central in processes of knowledge production and dissemination in the eighteenth and nineteenth centuries.[8] As Madeleine Schurch has aptly observed, the *Philosophical Transactions*, the first peer-reviewed journal, of the Royal Society was largely based on epistolary exchanges between scientists and the editor: 'Natural philosophers would address observations and experimental reports to the secretary of the Royal Society, Henry Oldenburg (1619–1677), which he would then publish often verbatim' (2019, 37). What is also important to note is the several critical editions of mathematical correspondences that were published in the nineteenth century, 'the most prolific period for collected works' to appear (see Borgato and Passeron 2018, vii), although the trend went on in the twentieth century and has now reached the days of the digital revolution, with important major editorial projects still being in the making.[9]

Mapping the contemporary field of mathematical correspondences, as well as their critical editions, Maria Teresa Borgato and Irène Passeron have argued that letter writing continues to be important in the spreading of scientific ideas 'even in times of a great number of specialized journals' (2018, vii). Moreover, mathematical correspondences display a great variety of topics beyond the remit of mathematical sciences, including 'letters between mathematicians and from mathematicians to politicians, publishers, and men and women of culture' (vii). Finally, it is not only the letters of famous mathematicians that are of interest in the history of mathematics; contributions from lesser-known mathematicians become a component of a wider assemblage 'in the reconstruction of biographies, as well as the genesis of scientific ideas, in analyzing relations and debates and, ultimately, in the correct dating and interpretation of various memoirs' (vii). Overall, the on-going digitization of mathematical works and correspondences 'is of major interest in the field of the history of mathematics' (viii).

In the context of epistolary worlds, as well as the digital turn in archival research, letters have become particularly important at throwing light in women's engagement with science in the eighteenth and nineteenth centuries and there is an increasing interest in scientific correspondences through a gendered lens.[10] Women have often studied mathematics in domestic settings, given their exclusion from universities and other

formal scientific societies and institutions up until the turn of the nineteenth century. Moreover, cultural historians have been interested in women's epistemological and intellectual involvement in the making of scientific knowledge, which included the development of mathematical sciences, but was also expanded in the wider cultural formations of modernity (see Rossiter 1982; Watts 2007). As Schurch has persuasively argued, 'the methods of scientific pursuit, literary creativity and cultural productivity were enmeshed and could, at moments, elide with each other' (2019, 18–19).

In thus looking at the letters that women mathematicians wrote, I trace ways in which women's epistolary writing, contributed to knowledge and research in mathematical sciences, but also reveal the minutiae of their constitution as subjects in science and mathematics, particularly focusing on the correspondence between Ada Lovelace and Mary Somerville, a rare epistolary relationship between women mathematicians, as I have already noted in the introduction.

Of numbers and machines

> Dear Mrs Somerville, I hope I may have the pleasure of meeting you on Saturday Evening at Mr Babbage's. I am going with Miss Montgomery to dine at Mrs Murchison's, and we shall be at Mr B [Babbage]'s for a short time in the evening. I have not seen him yet, but he sent a very respectful message through Mrs Murchison, inviting Miss Montgomery and me to his Saturday parties. I am afraid this may be my only chance of seeing you for the next three weeks. Hoping therefore to see you, believe me, Most Sincerely Yours,
> A. Ada Byron[11]

Having been introduced to Somerville in February 1834, Lovelace wrote a letter on March 19, 1834, setting a date for them at Charles Babbage's famous soirées, where he invited friends and acquaintances to discuss science, but also view his experimental machines. Babbage alongside John Herschel and George Peacock were amongst those scientists who wanted to revive the stagnant waters of British mathematics and they had all supported Somerville's work and particularly her translation of Laplace's *Mechanism of the Heavens* in this respect.[12] This first dinner party at Babbage's house on Dorset Street in Marylebone became one of many that Lovelace would attend sometimes with her mother, but always in Somerville's company, as it was not possible to go anywhere unchaperoned:

> My dear Mrs Somerville. I am very much obliged to you for your kindness, and shall be most happy to spend a few hours so delightfully on Friday. I shall be at No 10 Wimpole St by 1/2 past 11 o'clock, and as this is not out of the way from Chelsea to Mr Babbage's I should be obliged to you if you would be so good as to call at the door as you pass, and then our carriages can go together, as I should wish to arrive with you. I shall therefore wait in Wimpole St till I am summoned.
>
> Mama has never yet ventured out of the house, but she continues on the whole better, and hopes soon to have the pleasure of calling on you.
>
> With my kind regards to your daughters, believe me, Yours most sincerely obliged
>
> A. Ada Byron[13]

Apart from Babbage's dinner parties, Lovelace also attended a series of lectures on 'the Difference Engine' given at the Mechanics Institute by Babbage's friend Dionysius

Lardner, this time accompanied by her tutor's wife, Mary King. When his book, *The Economy of Machinery and Manufactures* was published in 1835, Lovelace was amongst its first readers. Indeed, she was quite taken by Babbage's inventions: 'I am afraid that when a machine, or a lecture, or anything of the kind, come[s] in my way, I have no regard for time, space or any other ordinary obstacles', she wrote to Somerville on July 8, 1834.[14]

Moreover, Lovelace's relationship with Somerville had woken up the teacher inside her. When touring the Midlands to see the new factories cropping up throughout England in the era of the Industrial Revolution, they visited her mother's friend Lady Gosford and her two daughters, Annabella and Olivia [Livi] Acheson at Buxton in Derbyshire. As Lovelace wrote to her teacher William King in September 1834, her new friends 'were amiable young women, with good natural abilities, but of rather indolent habits'.[15] She thus decided 'to excite and rouse them to various objects of study and interest, and as much as possible to make my little talents, such as they are, of use to my young friends',[16] and she particularly decided 'to induce one of them to take up mathematics'.[17] She soon found out that in teaching them 'I myself gain more perhaps than they do'.[18] Despite her newly found interests, Lovelace's fascination with Babbage's machines remained unwavering: 'This Machinery reminds me of Babbage and his gem of all mechanism'[19] she wrote in the same letter above, recommending a recent article on Babbage's work in the latest issue of the *Edinburgh Review*, which was run by intellectuals in agreement with the overall project of reforming British mathematics and science.

What is also interesting is that on returning to her home in Fordhook after the Midlands tour, Lovelace not only resumed her mathematical studies with renewed enthusiasm, but she also initiated a mathematical correspondence with her own chosen 'pupil' Annabella Acheson: 'So this you see is the commencement of "A Sentimental Mathematical Correspondence between two Young Ladies of Rank" to be hereinafter published no doubt for the edification of womankind'[20] she wrote to Annabella on November 10, 1834, ending her letter with the epistolary salutation 'Ever yours, mathematically'.[21] Later on in the same month she also confided to Annabella that 'Mr. Babbage and Mrs. Somerville are very kind indeed to me. The latter generally inquires with interest "how my pupil is going on?"'[22]

Lovelace's relationship with Somerville flourished throughout the summer and autumn of 1834, and during her visits to Babbage's dinner parties, she had the opportunity to follow some notable and intellectually intense conversations between the two mathematicians. Seeing a woman debating important questions in science and mathematics with a man must have had a lasting intellectual and emotional effect upon a young aspiring woman. Eager to understand more, she was borrowing the plans of Babbage's Engine and delved into his notes and papers through the mediation of her mentor and teacher:

> May I trouble you the first time you see either Mr Babbage, or his son, to say how exceedingly obliged I am to the latter for his unexpected kindness in sending me the plates & account of the Machine, which is exactly what I was in want of; and is a very great help to me. I am very busy copying the Steam Engine paper I carried off from Mr Babbage's the other day. I have finished two and expect to complete the 3rd in a few days. I hope he is not in want of them and would have no scruples in claiming them immediately![23]

Despite the difficulties of securing funding for his new inventions, something important was emerging from Babbage's work, which excited Lovelace even more and which she

described in detail to her mother, every time she returned from the scientific evenings held at his home. In December 1834, there is an entry in her mother's diary about Babbage's most recent work, recording a discovery 'in the highest department of mathematics [which included] the means of solving equations that hitherto had been considered insoluble'.[24]

But in February 1835, Mrs Somerville wrote a worrying letter to Lovelace's mother wondering whether their lessons should stop, since Lovelace had shown signs of extreme tiredness and agitation during her last visit. Lovelace wrote back admitting that she had felt 'shattered' and 'weak' when leaving her friend's house, to the point that 'at this moment [I] can hardly hold my pen from the shaking of my hand'.[25] Still she could not 'complain of being what people call ill'[26] and was adamant that their lessons continue, insisting that 'in a few weeks I dare say I shall be quite strong, (particularly if I see a good deal of you)'.[27] Somerville must have been deeply concerned with her protégée's physical state writing to her that 'riding on the downs and even in the riding school conduces more to health than reading mathematics'.[28] Riding was indeed what Lovelace did in recovering from this bout of over exertion, as the following letter from Brighton, where her mother had taken to recover in April, recounts:

> I am much stronger. I have been taking what has always been to me the finest of all medicines – horse exercise […] I generally ride in the riding school everyday, and – best of all – leap to my heart's content. I assure you I think there is no pleasure in way of exercise equal to that of feeling one's horse flying under one. It is even better than waltzing.[29]

Lovelace's relationship with Somerville soon unfolded beyond the boundaries of mathematics: 'I am going this evening to my friend Mrs Somerville's to stay the night. She has kindly offered to take me to a concert, which my love for music cannot resist',[30] she wrote to her future husband Lord William King on June 8, 1835, in one of the letters of their early amorous correspondence. King was a friend of Somerville's son from her first marriage, Woronzow Greig. As Greig's unpublished memoir reveals, he and most probably his mother had thought that King would be a perfect match for young Lovelace: 'During the Spring of 1835 I suggested to my friend Lord Lovelace, then Lord King, that she [Ada] would suit him as a wife'. He and I had been to college together (Trinity Cambridge) and were and have continued through life on the most intimate terms.[31] Lovelace's marriage to King, as well as the three children that followed soon after, temporarily disrupted her mathematical career, but not her perseverance in studying mathematics, as I will discuss next.

Of geometrical models and 'nasty daughters'

During the early years after her marriage, Lovelace often turned to Somerville for help and advice, trying to reassure her mentor and perhaps herself that her marriage was not going to dampen her desire and tame her passion for mathematics. Her first letter to her tutor was penned in the end of November 1835, when Lovelace already knew that she was pregnant with her first child:

> My Dear Mrs Somerville,
>
> You must not think that I have forgotten you, although it is so long since I have written to you. – I am ashamed to think how long. We only came home last week.

> I now write, partly to ask news, partly to give news, principally and, to remind you of your promises to visit us […]
>
> I now read Mathematics every day, and am occupied on Trigonometry and in preliminaries to Cubic and Biquadratic Equations. So you see that matrimony has by no means lessened my taste for those pursuits, nor my determination to carry them on, although it has necessarily diminished the time I have at command. But I suspect it is no bad thing to be limited in that respect.
>
> By the bye I have a mathematical question to ask you, which I hope is not too trifling to be beneath your notice. […]
>
> I am sorry to find that your copy of Legendre's Geometry is still in my possession. I thought I had returned it and my only excuse is my marriage.[32]

Somerville wrote back ten days later, apologizing for her late response on the grounds that she was very busy, giving Lovelace detailed answers to her mathematical questions, but also reassuring her around her ignorance: 'When you are more in the habit of using sines and cosines you will readily make out all the transformations but till that time I shall have great pleasure in giving you what aid I can'.[33] She also expressed her joy at her friend's health recovery from the discomfort of her early pregnancy: 'I rejoice to hear you go on so well, indeed I never saw you so strong and I have no doubt that your health will now be perfectly established'.[34]

This reassuring first letter was soon followed by more specific mathematical questions in a letter written only two weeks later: 'I have another trigonometrical question to ask you, and am encouraged by your kindness to trouble you with these things, which is a shame too, when you are so busy … '.[35] This letter also included news about Greig's and Babbage's visits to the King's residence at Okham Park, but also expressed her worries about her portrait, which was being painted by Margaret Carpenter.[36] Given that Somerville was an accomplished painter herself, Lovelace was asking her to have a look at it: 'The head of my picture is now completed, but I would rather not give my opinion of it, that your judgement may be unbiased. Mrs Carpenter would be very glad of your opinion and so should we'.[37]

The two women's correspondence continued through the very last days before Lovelace's confinement and on April 10, 1836 she felt at ease to share with her tutor and friend the way she imagined her yet unborn child: 'How much I should like to have a mathematical child, and only think what pleasure I should have in teaching it, and how capable I might hope to be too by the time it was old enough'.[38] The neutral pronoun in this short extract clearly expresses Lovelace's plans for her child to be, irrespective of its gender. But in a letter penned sometime in early 1837, in anticipation of her second child, Lovelace dared to confess to her friend that she would prefer a boy rather than a girl:

> I am so exceedingly well that I can hardly think there is to be a second yet. I am sure if there is, it must be a boy, for a girl, never would leave me in peace. You see I cannot help being spiteful about the nasty girls, and suppose I never shall until I have something in the feminine gender.[39]

We cannot be sure how the figure of 'the nasty girl' enters Lovelace's epistolary discourse, other than the fact that she had a difficult relationship with her mother. As Somerville's son and Lovelace's friend and confidant wrote in his unpublished memoir:

> Lovelace's feelings toward her mother were more akin to awe and admiration than love and affection. The familiarity of mother and daughter never subsisted between them, there was always a degree of repulsion and distrust although they were proud of each other.[40]

It was perhaps in this psychological backdrop that in a letter to her mother written on December 12, 1840, Lovelace admitted that 'I am not naturally or originally fond of children […] and though I wished for heirs, certainly should never have desired a child'.[41] Just a day later she wrote to Mrs Barwell, a prospective governess how she felt about children:

> I have been thinking much of my qualities as a Mama or Guardian of children, and I have come decisively to this conclusion: I am admirable as an *organizer, director of others, superintendent*. But practically in details, the less I have habitually to do with children the better both for them and me […] How many moments there are, when their presence is most irritating and intolerable to me, and when a third person given up to them, makes it quite a different thing. Add to this my total deficiency in all natural love of children […] and an exceedingly delicate and irritable nervous system … and you will not wonder that I begin to feel them occasionally (to speak plainly but truly) a real nuisance […] I believe I am fit to educate, with proper aids. But … as the Chief, the general.[42]

Three years later and on the wake of her published paper on Babbage's *Analytical Engine*, Lovelace decided that she was now a recognized and acknowledged scientist, and it was from this subject position that she looked for a tutor:

> I am now a completely professional person, to speak plainly; and am engaged in studies and in literary and scientific avocations, which render me quite unable (were I even fitted by nature, which I am not), to associate much personally with my children, or to exercise a favourable influence over them by attempting to do so.[43]

It seems however that Lovelace's disposition towards her daughter eventually changed, as a letter to her mother, penned sometime in 1844 clearly shows:

> You cannot think how charmed I am with my *metaphysical* child and how I have thought of her. If she will only be kind enough to be a metaphysician and a mathematician instead of a silly minikin dangling miss in leading strings I shall love her mind too much to care whether her body is male, female or neuter. But really, all joking apart, I feel there is that in her which I shall delight to commune with as she comes to maturity (& which has nothing to do with her sex either way).[44]

Lovelace's ambivalent feelings about her children stage the contradictions that women of her era faced in trying to engage with the world of science, while also maintaining their role as dutiful wives and loving mothers. As Julia Swindells has aptly observed, Somerville's decision to write her *Recollections* was in effect an act of reckoning with the past, making sense of what it meant to live a life in/for science while at the same time being a woman, a daughter, a wife and a mother: 'an autobiography which negotiates (abetted by editorial processes) its subject, its first person, and its narrative around the relationship between science and domesticity' (1999, 100).

Irrespective of her fluctuating moods towards children in general and her daughter in particular, Lovelace's interest in her mathematical studies remained unwavering throughout her second pregnancy. It was during this time that she received Babbage's book *The Ninth Bridgewater Treatise*, which was looking into the connection between science and religion. As her correspondence with Somerville shows, Lovelace was apprehensive of the book, as she had some debates with Babbage about its content during its preparation, and she was afraid that its publication had been somewhat rushed, as she wrote to her mentor on June 22, 1837:

> I am longing to see Mr B [Babbage]'s book. From Mama's account of it I have gathered it is a pity it was written in much haste and is so fragmentary and underdeveloped in its character It is a pity it was written in such haste and is so fragmentary and undeveloped in its character. It seems to resemble one of the curious (multum in parvo) algebraical expressions of which you know infinitely more than I do, which under a few simple symbols involve and indicate to the initiated quantities endless in their complication and variety of mutual relations. But what a pity that such a mind has not in some degree filled up the crude outlines, for the benefit of those who could not! […] However I am criticizing what I have not read.[45]

What is important to consider here, is that Lovelace felt quite at ease to share with Sommerville quite serious reservations about the work of an eminent mathematician of her time. In the context of her epistolary discourse, she and her recipient were perfectly able to discuss and criticize Babbage's work, as simply his peers:

> I fear the work will be underrated, and the circumstances you mention of the extreme haste fully accounts for this, though it in fact enhances its merit and indicates the more what might be. However, I am criticizing what I have not read.[46]

As her letter further relates, Lovelace was eager to share her criticism with Babbage himself, but still needed Somerville's advice on that: 'I think when I have read it […] I shall probably give my opinion to Mr. B. himself. Would this be presumptuous do you think?'[47] she asked her, further reassuring her that she was doing 'a little here at a very snail's pace in Mathematics'.[48]

By 1838 Lovelace had her third child, but Somerville had moved to Italy, so their correspondence became less frequent, while the famous Augustus de Morgan, first professor of Mathematics at the University of London and firm supporter of Higher Education for women became her tutor in advancing her study of mathematics (see Hollings, Martin, and Rice 2017). When her paper on Babbage's *Analytical Engine* was published in 1843, Lovelace proudly sent it to Somerville who immediately replied from Italy, congratulating her on her achievement 'in the highest branches of mathematics, and the clearness with which you have illustrated a very difficult subject'.[49] But she also advised Lovelace against overwork, as she had heard from friends that she looked thin and peak. Their epistolary relationship never stopped being scientific and personal as I will further discuss.

Mathematical imagination and broken genealogies

As I have already shown in the previous sections, the personal and the scientific are continuously intertwined in the two women's correspondence: 'I am very much delighted to have a cap made by you and the more so as it shows [that] we mathematicians can do other things besides studying xes and ys', Somerville wrote to Lovelace'.[50] Indeed, Somerville tried to maintain the image of a woman who excels in science and mathematics without neglecting her domestic roles.[51] It goes without saying that such a stance was a discursive tactic, or what I have called a 'technology of resistance', elsewhere in my work with women students of the first women's colleges, associated with Cambridge university (see Tamboukou 2003). Encouraging Lovelace in matters, such as the embroidering of a cap, was thus a component of such entanglements between the scientific and the domestic. But apart from signifying Lovelace's and Somerville's engagement with the domestic the embroidered cap is also a sign of the material and earthy ways that the women were entangled in their scientific

pursuits. For Lovelace, mathematics was not just about solving abstract problems, formulas and equations. We have already seen in the previous section that Lovelace's letters to Somerville raise questions about mathematical problems, but they also seek for visual and tactile representations of mathematical concepts:

> My Dear Mrs Somerville,
>
> Can you tell me if any solid models have ever been made for illustrating some of the Propositions of Spherical Geometry, and if so where such things are best to be had. Next to this, some extremely good plates on the subject would be a great help. The kind of propositions I refer to are those on the intersections of Circles of the Sphere; for instance the following, which I take from Spherical Geometry which precedes Lardner's Spherical Trigonometry […] These are enough to put me in despair and I have been in danger of turning crazy in trying to imagine the circles in my mind's eye.[52]

In this letter, written from Ockham Park on March 25, 1836, less than two months before Lovelace gave birth to her first child, Byron, Lovelace highlights the importance of visual thinking in mathematical practice. In response, Somerville promised to ask Babbage's help, but also tried to reassure Lovelace's anxiety: 'Pray don't let the circles turn you crazy till we meet, for I am sure I can explain them to your satisfaction viva voce, though I doubt of my talents that way on paper'.[53]

This epistemic stance to ground abstractions and unleash forces of the visual imagination is acknowledged in contemporary debates of the philosophy of mathematics (see Giaquinto 2008) but not in the mathematical circles of the Victorian period. As a matter of fact, women's aptitude in mathematics was being dismissed precisely on the grounds of their supposed incompetence for abstract thought, even amongst the philosophers of the Enlightenment. Immanuel Kant for example had famously argued that women's mind was different from men, in that it was not made for abstract thinking, concluding that 'a woman therefore will learn no geometry' (1960, 79). Lovelace seems indifferent to such ideas and appeals to Somerville for help in imagining the circles of the sphere. Coming from an older generation, as she was thirty-five years older than Lovelace, Somerville seems to have internalized such discourses as a famous extract from the second draft of her *Recollections*, which was never published, reveals:

> In the climax of my great success, the approbation of some of the first scientific men of the age and of the public in general I was highly gratified, but much less elated than might have been expected, for although I had recorded in a clear point of view some of the most refined and difficult analytical processes and astronomical discoveries, I was conscious that I had never made a discovery myself, that I had no originality. I have perseverance and intelligence but no genius, that spark from heaven is not granted to the sex, we are of the earth, earthy, whether higher powers may be alotted to us in another state of existence God knows, original genius, in science at least, is hopeless in this. (Somerville 2001, 168)

Somerville follows here what Ruth Messbarger has identified as 'the double-voiced discourse that simultaneously defied and affirmed misogynist constructions of femininity' (2005, 18) in the early modern period and beyond. On the one hand she defends women's right to education and therefore engagement with science, but on the other hand she offers an apology for the defects of her sex, by acknowledging her position as an expositor rather than creator of scientific knowledge, a creature 'of the earth' and not of the sublime spirit.

Lovelace's intervention in such discourses was crucial: at the same time of admitting that she was 'turning crazy in trying to imagine the circles in my mind's eye'[54] she also held the firm belief that imagination should delve into the unexplored by 'seizing the unseen'. Her 1841 essay on the importance of imagination for scientific work is the best response to some of the misogynistic ideas that we have examined above. In Lovelace's configuration, imagination is twofold: it combines, 'bringing together things, facts, ideas, conceptions, in new, original, endless, ever varying, Combinations'[55] and 'it conceives and brings into mental presence that which is far away, or invisible, or which in short does not exist within our physical and conscious cognizance'.[56] In this light imagination is 'the Discovering faculty […] that which penetrates into the unseen worlds around us, the worlds of Science'.[57] Thus Lovelace needs 'geometric models', as material aids for the work of imagination to unfold: 'Mathematical Science shows what is. It is the language of unseen relations between things. But to use and apply that language we must be able fully to appreciate, to feel, to seize, the unseen, the unconscious'.[58]

Lovelace's take on imagination as a 'discovery faculty', a path to the yet 'unseen' echoes Sophie Germain's philosophical approach to the creative forces of imagination. Being the first woman to win the *Grand Prix des Mathématiques* from the French Institute in 1816, one year after Lovelace's birth, Germain was also an important philosopher, whose work had been celebrated by her contemporary philosophers, such as Auguste Comte:

> We would imperfectly appreciate the high range of Mademoiselle Sophie Germain, if we limited ourselves to consider her as a mathematician [géomètre], whatever the eminent merit she demonstrated in mathematics. Her excellent posthumous discourse, published in 1833, on the state of science and the letters in the different periods of their culture, indicates in her a very lofty philosophy, both wise and energetic, of which very few superior minds have such a clear and profound feeling today. I will always attach the highest value to the general conformity that I saw in this writing with my own way of conceiving the whole intellectual development of humanity. (Comte 1835, 604n1)

In her philosophical work, Germain compares the impressions we get from fictional and scientific works and concludes that there are no important differences between them. In making these comparisons, Germain carefully demonstrates the identity of intellectual processes both in poetry and in science by showing that there is a continuous interchange of feelings [sentiments], imagination and rational reasoning in the way they unfold. For the poet there is 'a tumultuous struggle' of abstract images and opposing projects until a simple idea finally emerges (1896, 82). For the mathematician there is also a simple, 'fruitful idea' that arises through [his] struggle with imagining a new problem in areas already researched and established:

> he sees results he cannot yet achieve; his imagination soars, to seize them, in the roads it has blazed; he fears he has lost his way, he doubts his first glimpses, he retrogrades and tries to re-enter the indications which had first guided him; a large number of ideas joined those which were the first; they complicate matters, share attention and suspend judgment. But, through this chaos of thoughts, the genius distinguishes a simple idea; his choice is irrevocably fixed, he knows that this idea will be fruitful (83).

In tracing the process of creation, Germain also points to the importance of the choice of style and makes reflections of remarkable accuracy on the perfection of language in literature and of 'the language of calculations' in mathematics: 'the man of letters will take care of the choice of words, their arrangement, the harmony of the verse or that of the

sentence' (86). But the mathematician also needs to attend to the demands of style, since the language of calculations also has its own aesthetics: the choice of words in literature corresponds to the choice of mathematical expressions, which can be 'more or less elegant' (83) as 'not all authors write it with the same degree of perfection' (82).

Germain's eloquent philosophical treatment of the importance of mathematical imagination precedes Lovelace's short essay 'What is imagination' that we have discussed above, but there is no evidence that Lovelace knew of Germain's work. As a matter of fact, we don't even know that Somerville knew about Germain, as there is no reference whatsoever in her work, either in the *Recollections* or in her scientific publications. This absence of communication is very strange, particularly if we consider that Somerville first visited Paris in 1817, one year after Germain had become the first woman to win a prestigious award from the Paris Academy of Sciences for her mathematical theory of vibrations of general curved and plane elastic surfaces (see Musielak 2020, 83). Indeed, many of the French mathematicians and scientists that Somerville refers to in her *Recollections* both knew and were in correspondence with Germain. They had certainly read and examined her work as members of the Class of Mathematics and Physics of the *Institut de France*, who had awarded Germain the prize.

In her *Recollections*, Somerville refers to a dinner party in Paris that Madame Biot held 'on purpose, as she said, to show us, "les personnes distinguées"' (2001, 117). Among the distinguished persons that they met at this party was 'Monsieur and Madame Poisson, who had only been married the day before' (118). We know however from Germain's biographers, her scientific correspondence with Poisson (Germain 1896, 307–308), as well as public debates and acrimonious exchanges in scientific journals (Musielak 2020, 108–109), that 'Poisson was no friend of Sophie Germain' (165), that he had refused to acknowledge her as his peer and that he considered her as 'a competitor in the quest to derive a theory that he must have thought was too formidable for an amateur like her, or that he believed was his own' (165).

Germain was a single woman and did not have many opportunities for being invited to dinner parties or otherwise socializing with scientists and their wives, in the way Mr and Mrs Sommerville were. Brigitte Stenhouse (2021b) has written about William Somerville's support for his wife, as well as about the importance of scientific households in the circulation of mathematics in nineteenth century Britain (Dunning and Stenhouse 2021). It seems however that such arrangements were limited for single women like Germain, despite her important and original contribution in the mathematical sciences in post-revolutionary France. It is perhaps on the grounds of such heteropatriarchal regimes that Somerville never met Germain in Paris and subsequently Lovelace never read her philosophical work, which was first published in 1833. What a beautiful world these three women mathematicians would have created if only they knew of and communicated with each other, in the way Lovelace and Somerville had done.

Letters, gender and mathematics

In this paper I have looked at the mathematical correspondence between two renowned women mathematicians and scientists of the Victorian period, while also considering the imperceptibility of an important French mathematician and philosopher in post-revolutionary France. Drawing on the importance of mathematical correspondences in the

creation, circulation and dissemination of mathematical knowledge, as well as in processes of formal and informal learning, what I have argued is that Lovelace's and Somerville's letters leave traces of an important genealogical line of women's networks in the nineteenth century world of British mathematics. In becoming Lovelace's mentor and advisor, Somerville put in practice her ideas about the importance of women's higher education, a firm stance that she materialized not only by teaching Lovelace, but also by bequeathing her rich mathematical library to Girton College, whose foundation in 1869 she had both hailed and supported (see Somerville 2001, 291).

In doing so I have unravelled complex entanglements between the personal and the scientific in the two women's correspondences particularly tracing uneasy relationships and contradictory discourses in the constitution of the female self in mathematics. Finally, by considering the glaring absence of any reference to Sophie Germain's work in the two women's epistolary and philosophical writings, I have pointed to the exclusions of the heteropatriarchal regimes of the nineteenth century, many of which reach our own days, if we consider the sore state of women in mathematics in the twenty-first century.

Notes

1. Ada Byron to William Frend, Oxford Bodleian Libraries, Archive of the Noel Byron and Lovelace Families, Dep. Lovelace Byron 171. Thereafter [OBL/MSC/LB].
2. Augusta Ada Byron, later became Augusta Ada King and Lady Lovelace, but for the sake of clarity I will refer to her as Lovelace in this paper.
3. William Frend to Ada Byron, dated 1834 [OBL/MSC/LB/71].
4. For a comprehensive review of the literature around Somerville see Stenhouse (2021a), and for Lovelace, Hollings, Martin, and Rice (2018).
5. See amongst others, Moore Langley (1977), Stein (1985) and Toole (1992).
6. See also Martin (2020) for a recent overview of the literature on women's epistolary writing in the Victorian period.
7. See https://sites.google.com/view/numbersandnarratives/a-feminist-genealogy-of-automathographies for details of this project [Accessed 5 August 2023].
8. See amongst others, the Darwin letters project on the importance of letters in Darwin's scientific work, https://www.darwinproject.ac.uk/ [Accessed 24 July 2022].
9. See amongst others: Newton's correspondence in the Newton Project: https://www.newtonproject.ox.ac.uk/texts/correspondence/all; the Leibniz Correspondents and Acquaintances project (LCA), https://www.leibnitiana.eu/; The Correspondence of the mathematician Bernoulli project: https://tcdh.uni-trier.de/en/projekt/correspondence-mathematician-bernoulli [Accessed 24 July 2022].
10. See George (2011) and Schurch (2019) for an overview of the literature.
11. Lovelace Byron to Mary Somerville, letter dated March 19, 1834, Oxford, Bodleian Libraries, Mary Somerville Collection, Dep. c. 367. Thereafter [OBL/MSC/c.367].
12. See amongst others, Flood, Rice, and Wilson (2011), Stein (1985).
13. AB to MS, letter dated November 26, 1834 [OBL/MSC/c.367] [E51].
14. AB to MS, n.d. [OBL/MSC/c.367].
15. AB to Dr. William King, letter dated September 1, 1834 [OBL/ANBL/LB/172] [E46].
16. Ibid.
17. Ibid.
18. Ibid.
19. Ibid.
20. AB to Annabella Acheson, letter dated November 10, 1834 [OBL/ANBL/LB/168].
21. Ibid.
22. Ibid., letter dated November 24, 1834.

23. AB to MS, November 8, 1834 [OBL/MSC/c.367].
24. Annabella Byron, unpublished diary, December 15, 1834 [OBL/ANBL/LB/117].
25. AB to MS, letter dated February 20, 1835 [OBL/MSC/c.367].
26. Ibid.
27. Ibid.
28. MS to AB [OBL/ANBL/LB/174].
29. AB to MS, letter dated April 4, 1835 [OBL/MSC/c.367].
30. AB to Lord William King [OBL/ANBL/LB/168] [M66].
31. Greig memoir [OBL/MSC/b.206].
32. AL to MS, letter dated November 1, 1835 [OBL/MSC/c.367].
33. MS to AB, November 28, 1835 [OBL/ANBL/LB/174].
34. Ibid.
35. AL to MS, letter dated November 18, 1835 [OBL/MSC/c.367].
36. https://upload.wikimedia.org/wikipedia/commons/8/87/Lovelace_Lovelace.jpg.
37. AL to MS, letter dated November 18, 1835 [OBL/MSC/c.367].
38. AL to MS, letter dated April 10, 1836 [OBL/MSC/c.367].
39. AL to MS, n.d., early 1837 [OBL/MSC/c.367].
40. Greig, unpublished memoir, n.d. [OBL/MSC/b.206].
41. AL to her mother, December 12, 1840 [OBL/ANBL/LB/41].
42. AL to Mrs. Barwell, December 13, 1840 [OBL/ANBL/LB/168].
43. AL to Noel Byron, August 9, 1843 [OBL/ANBL/LB/173].
44. AL to her mother, n.d., c 1844 [OBL/ANBL/LB/42].
45. AL to MS, June 22, 1837 [OBL/MSC/c.367].
46. Ibid.
47. Ibid.
48. Ibid.
49. MS to AL, February 5, 1844 [OBL/ANBL/LB/174].
50. MS to AB, n.d., C. 1834 [OBL/ANBL/LB/174].
51. See Jenkins (1999), Swindells (1999).
52. AL to MS, letter dated March 25, 1836 [OBL/MSC/c.367].
53. MS to AB, n.d. [OBL/ANBL/LB/174].
54. AL to MS, letter dated March 25, 1836 [OBL/MSC/c.367].
55. Essay on Imagination, January 5, 1841 [OBL/ANBL/LB/175].
56. Ibid.
57. Ibid.
58. Ibid.

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