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Mathematicians, Mysteries, and Mental Illnesses: The Stage-to-Screen Adaptation of *Proof*

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Abstract The aim of this article is to investigate why and how the three topics involving mathematicians, mysteries, and mental illnesses are interlinked in David Auburn's award-winning play *Proof* (2000) and John Madden's eponymous screen adaptation (2005). Based on Mikhail Bakhtin's chronotope and Gérard Genette's concept of transtextuality, the article will consider references to historical mathematicians, psychiatric and psychoanalytical discourses as well as media-related techniques used by the play and the film adaptation. Our objective is to shed light on *Proof's* representation of a largely self-taught female mathematician who rightfully demands professional recognition. We will focus on two main questions: 1) Why do the skills of allegedly "mad mathematicians" arouse doubt once the latter are female, whereas geniality and madness are not mutually exclusive when the fabled connection is related to male scientists?, and 2) What kind of insights do the spatio-temporal references of Madden's filmic adaptation have to offer in terms of gender and science? We argue that the cinematic adaptation is less ambiguous towards the question of female authorship of the mathematical proof, but at the same time the hypertext refers to films and film genres that seem to amplify the protagonist's mental instability. We conclude that it is precisely this juxtaposition of a female scientist performing high mathematics and the adaptation's sometimes contradictory chronotopic frames which serves as an effective critique of gendered stereotypes of women performing maths.

Keywords: *mathematics, drama, gender, science, Bakhtin, Genette.*

ADAPTATION STUDIES: FOLLOWING A BAKHTINIAN AND GENETTIAN PATH

Although the 'morally loaded discourse' (Hutcheon 7) about an adaptation's 'faithfulness' has been widely rejected (Deborah Cartmell, Imelda Whelehan, Robert Stam, Thomas Leitch), theorists are still reluctant to explicitly define what an adaptation actually is (Leitch 89, 88). In the second edition of Hutcheon's ground-breaking book *A Theory of Adaptation* (2012), the author continues to admit that 'adaptation [is] rather difficult to theorize' and instead describes it as both a 'product' and a 'process' (9). Adaptation as a product can involve a shift in medium, for instance, when a drama

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is adapted to the screen, in which case Hutcheon speaks of 're-mediations' (16). As a process, an adaptation functions as an 'act of appropriation' which is 'always a double process of interpreting and then creating something new' (20). According to Hutcheon, this is the main reason why fidelity criticism is inadequate for a discussion of adaptation as the latter is to be understood as fluid (20). Referring to Bakhtin, she rather describes adaptation as an 'ongoing dialogical process', as an unavoidable kind of '*intertextuality if the receiver is acquainted with the adapted text*' (emphasis in the original 21). This idea is present in *Literature and Film* (2008) by Robert Stam who outlines adaptation not only as a hybrid 'orchestration of discourses' but also calls for a move towards 'more diffuse notions like "textuality"' (9). In the light of film adaptation and its media specificity, Stam points to the 'analytical productivity' (26) of intertextual concepts, namely Bakhtin's notion of the chronotope and Genette's transtextual tools. According to Stam, the concept of the chronotope has the following to offer:

> The Bakhtinian notion of the "chronotope" […] helps illuminate adaptation, allowing us to historicize our understanding of space and time in both film and novel. The chronotope […] helps us understand the ways in which spatio-temporal structures in the novel evoke the existence of a life-world cued by the text but also independent of it. The concept […] assumes that stories "take time" but they also "take space;" […] it is ideally suited to a medium like the cinema where [space and time are merged into one single entity]. (26)

By treating the drama as an equal to the novel or any 'script', we wish to seize upon this concept and Genette's typology of transtextual relation (Genette 1–7), as they allow us to carve out the media-specific and sometimes contradictory chronotopic frames that enable the film adaptation to criticise stereotypical ideas of gender and science on a multireferential level. This would, of course, include metatextual references to the source text and their potential to support a modified reading (Genette 4; Stam 28). We do not aim at proposing a new definition of adaptation. In line with Thomas Leitch, we defer this question (100) and follow Stam who, as a Genettian disciple, paraphrases cinematic adaptations as 'hypertexts derived from pre-existing hypotexts which have been transformed by operations of selection, amplification, concretization, and actualization' (31).

KEY LIGHT ON MATHEMATICIANS: A SPATIO-TEMPORAL APPROACH TO THE PLAY *PROOF* AND ITS FILM ADAPTATION

In *Math Horizons*, the quarterly periodical of the Mathematical Association of America, Stephen Abbott's review of the new century's first decade correctly observes that 'in the last ten years or so there has been a remarkable amount of activity at the intersection of science and theatre' (Abbot 18). David Auburn's play *Proof*, which premiered at the Manhattan Theatre Club on May 23, 2000, certainly contributed to this development. The play and John Madden's eponymous film adaptation (2005) are prime examples of what Karen C. Blansfield in an almost Shakespearean mood calls a 'happy marriage of art and science' (Blansfield 1) as they manage 'to transmute potentially unappealing or inaccessible science into compelling drama' (ibid.).

The play and film share the major plot line: The young protagonist Catherine has just lost her father Robert who was a mathematical genius but also mentally ill. She

seems to have inherited some of his talents but never completed her formal education, because she had to care for her father. After Robert's death, his former protégée Hal discovers a notebook containing an extraordinary proof which Catherine claims to have written. The constant questioning of Catherine's credibility forms the core of the narrative in the play as well as in the film, the latter starring Anthony Hopkins as Robert, Gwyneth Paltrow as Catherine, and Jake Gyllenhaal as Hal.

In the following, we will discuss the representations of the mathematicians, the mysteries related to the proof, and the mental illnesses as portrayed in both the play and the film against the backdrop of Mikhail Bakhtin's chronotope (Bakhtin 7) in tandem with Genette's well-known concept of transtextuality (Genette 1–7). We argue that the play and the metatextual film adaptation (Genette 4; Stam 28) establish a paradoxical pattern in that they perpetuate and simultaneously challenge well-known stereotypes of mathematics and its representatives. On the face of it, what the play and the film have in common is a recurring doubt about Catherine's mental stability and hence her trustworthiness as a female mathematician in a male-dominated sphere. Even when we take into account that Catherine as a heroine is in the limelight, a closer look reveals that it is precisely her authorship as a *female* mathematician which, as a matter of principle, is scrutinised far more thoroughly than her father's abilities—despite his confirmed mental illness. Building on this conjecture, we would like to rephrase Christina Wald's pointed questions posed in *History, Trauma and Melancholia* (2007) as follows: Can the daughter 'possibly match the father's genius' (176)? Can Catherine actually be as smart as Robert? Is it possible for an allegedly mad *female* mathematician to be as good as a mad *male* mathematician? In her ground-breaking book on theatre, gender, and performative malady, Wald stresses the very old association of 'masculinity, mental instability […] and artistic excellence' as an 'ennobled form of melancholia' (ibid.) in opposition to 'depression'—the female and pathological equivalent of this melancholic state of mind. Needless to say, this gender-biased stereotype is still very much alive today and can be read against the grain of both the play and the adaptation of *Proof*. Put simply, Wald's observation can be summarized by the following equation: *man* + *melancholia* = *genius*, while *woman* + *melancholia* = *illness*. What we wish to investigate in this paper is how the film adaptation of *Proof* negotiates this gendered stereotype in comparison to its dramatic hypotext.

The metatextual film adaptation, while offering more cues to solving the question of the proof's authorship in favour of the heroine, still tends to intensify the ambiguity of Catherine's sanity. It does so by employing certain intertexts, film genre references, unreliable forms of narration, playing with visual metaphors, and by utilizing media-specific techniques. Our thesis proposes that it is exactly the contradiction between an apparently 'mad' female mathematician and some revealing chronotopic frames that ironically affirms her capability of performing high mathematics in a male-dominated world. These discrepancies between madness and mathematics, mysteries, and proofs create a particular spatio-temporal texture in the film adaptation that can be regarded as a potential space of agency for a female mathematician struggling for recognition in the masculine world of science.

This essay is divided into three parts. First, we introduce the play's subtle inversion of stereotypical mathematicians, briefly hint at gender and mathematics, and investigate

the role of mathematics in the play. Second, we explore the mysteries which the play and film present. Above all, these include the question of female authorship but also the nature of the proof and the reliability of the heroine's friend. Thirdly, this paper focusses on another profound mystery, the question of Catherine's mental (in)stability to be addressed on the basis of selected scenes from the cinematic adaptation of *Proof*. The filmic hypertext in particular offers more interpretative leeway with regards to the issue of Catherine's credibility and this is mainly due to the media-specific techniques it uses.

MATHEMATICIANS: STEREOTYPES, GENDER AND CHRONOTOPIC FRAMES

'Mathematicians are insane' (Auburn 30). With this statement, Hal, the former Ph.D. student, seems to willingly accept the stereotypical notion of what Kenneth Faulkner has playfully labelled the 'Mathematical Misanthrope', which regards mathematicians as 'brilliant, but socially inept and eccentric' (Faulkner 201). In Auburn's play, Robert and his daughter Catherine appear to be prime examples of this view. Catherine, for instance, bears stereotypical traits of the socially inept mathematician as can be deduced from her haphazard appearance (Auburn 5; stage directions), her lack of friends (ibid. 7) and her rational rather than emotional behaviour (ibid. 16). She also displays the 'logical precision in common language [which] is typical of mathematicians' (Vistoli 328). Indeed, especially the film adaptation establishes a chronotopic frame of meaning by drawing on typical features of math films to accommodate established viewing habits (see Fiebig and Klohs). It clearly models Robert on John Nash, the brilliant but schizophrenic mathematician as depicted in Ron Howard's film *A Beautiful Mind* (2001). Similar to Nash, Robert is obsessed with a secret code which he thinks was sent to him through library books (Madden 00:25:50-00:26:15). While Nash 'is shown scribbling formulas on every available surface, in a state that is indistinguishable from his later insanity' (Mendick 7), Robert uses his notebooks to compile his ideas (Auburn 17; Madden 00:08:15-00:08:27). In the end, Nash's 'deviant psychotic vision' is restored through 'the eyes of his "normal" wife', who embodies a reliable perception (Donaldson 43), and, likewise, Robert's insanity is revealed through Catherine's discovery of the content of his notebooks (Auburn 63; Madden 1:22:30–1:23:50).

A refreshing exception to the stereotypical mathematician is Hal. His rather untypical behaviour for a mathematician places him in direct opposition to Catherine and supports what Carol Schafer calls the 'fairy-tale plot' (Schafer 1). According to her line of argument, Hal is Catherine's knight in shining armour who rescues her and, consequently, places her in the position of a 'damsel in distress.' Thus, as Schafer points out with regard to Auburn's play, '[o]n its surface, *Proof* deceptively claims to challenge perceptions of women as incapable of authority in fields that have been traditionally dominated by men; however, the familiar affirmation of patriarchal hegemony lurks beneath the surface' (ibid. 13). Hal even voices the academic view of mathematics as 'a young man's game' and confirms his ignorance of female mathematicians, when he does not immediately recognize the name of the French mathematician Sophie Germain (1776–1831) (Auburn 30–31; Madden 00:29:55-00:30:12).

In comparison to other math plays (Shepherd-Barr 128), *Proof* provides a realistic illustration of mathematics (Schafer 1; Ullman 340), offers outsiders insights into the world of mathematicians (Blansfield 7) and captures the reality that 'research is made of hard and unceasing work' (Vistoli 328). In regard to Germain primes, Ullman suggests that Hal's way of defining these numbers 'would be patronizing to another mathematician' (ibid.), in this case to Catherine. However, this would merely confirm the argument that Catherine has to overcome the stereotypes of her gender in relation to mathematics. Going even further, it is this scene in particular that establishes Catherine as a very talented and able mathematician because she counters Hal's simple example 'Like two. Two is prime, doubled plus one is five: also prime' with a more complicated and impressive example 'Or 92,305 times $2^{16,998}$ plus one' (Auburn 31), which startles Hal. Regarding the Hardy–Ramanujan number 1,729, Ullman argues 'Mathematicians, particularly father and daughter, would have a silent rapport on this' (Ullman 341). Yet the exchange between father and daughter hints at their very close relationship and attests to the informal mathematical education Catherine received from her father.

Above all, Catherine's detailed knowledge about Sophie Germain's biography, which is not featured in the film adaptation to the same degree, as well as her mathematical background not only provide a definition of Germain primes (Auburn 31) but also hint at the difficulties endured especially by female mathematicians. As Harold M. Edwards observes in *Fermat's Last Theorem*, Germain was 'one of the very few women to overcome the prejudice and discrimination which have tended to exclude women from the pursuit of higher mathematics' (Edwards 61). The explanation of Germain primes (Auburn 31), Robert's earlier statement that Catherine 'knew what a prime number was before [she] could read' (ibid. 7), and the mysterious proof about prime numbers (ibid. 40) permeate the play and, in a metaphorical sense, bind these two women together. Despite Elizabeth Klaver's sweeping complaint that prime numbers are 'not essential to the play in any structural, formal, or narrative way' and that 'their appearance is quite arbitrary' (ibid. 7), they firmly establish nothing less than the chronotopic reference between Germain and Catherine, position Catherine as Germain's contemporary double and foreshadow the events in the play. The two female mathematicians did not receive or complete a formal education (Auburn 31). Both also took on male identities; Germain sent letters to Carl Friedrich Gauss including mathematical proofs using a male pseudonym, and Catherine equally assumes a male identity by hiding her notebooks in her father's desk (Edwards 61). Germain and Catherine thus both aim(ed) at gaining access to the male-dominated academic world without being rejected due to their gender or lack of formal education. Choosing an almost identical fate to Germain's for Catherine, Auburn's play draws attention to the still prevailing gender inequality and reiterates 'that women mathematicians have traditionally existed outside the academic mainstream' (Alker and Davidson 183).[1] In contrast, Madden's screen adaptation neglects this strong bond between Catherine, Germain and prime numbers. First, the film mentions the latter mathematician only briefly (Madden 00:29:55-00:30:42) and, therefore, lacks an 'identity-establishing model' for Catherine (Fiebig and Klohs 225). Second, it does not name prime numbers as the subject of Germain's

proof at all and, by ignoring the parallels between the two women, rules out one aspect of a critique of the contemporary male-dominated academic world.

Although Catherine has clearly inherited some of her father's talent, her mathematical abilities are questioned throughout the play which thus further affirms chronotopic gender stereotypes, as Suzanne K. Damarin's states: 'women in mathematics are doubly marked (as women and as mathematical), making their position doubly difficult socially' (Damarin 69). This becomes especially clear when we consider Hal's questioning of Catherine's authorship. In addition to insisting on an informal investigation of the proof—a standard procedure in the world of mathematics—he has doubts about her mathematical skills when he questions her ability to identify valuable material among her father's notebooks (Auburn 17–18, 53). Hal's attitude seems to be symptomatic of the chronotopically designed academic discourse that is still dominated by men who firmly believe in institutional training. Catherine rightly rejects the notion that performance in higher mathematics presupposes formal education (ibid. 55) but accepts the established procedure in the end when she agrees to have her proof scrutinised by members of Hal's department (ibid. 53).

Both play and cinematic adaptation establish the characters as mathematicians but at the same time challenge and provoke the audience in different ways: first, to simply trust the verisimilitude of the mathematics on stage, second, to research what they have seen and therefore engage in mathematics themselves and, third, to accept the incomprehensible nature of the topic as such and concentrate on other aspects of the play. Not even the alleged proof in the ambiguous title is explained in more detail and the theatre audience only learns that it is a very important proof of a 'mathematical theorem about prime numbers, something mathematicians have been trying to prove since there were mathematicians' (Auburn 40). This omission of mathematics 'reinforces the prejudice that mathematics is mysterious, unavailable to the average person, too hard to even bother presenting' (Klaver 6). What remains, though, is the mystery of female authorship which will be dealt with in the next section.

MYSTERIES: THE PROOF, FEMALE AUTHORSHIP, AND A FRIEND'S RELIABILITY

While we have to concede that the actual proof of a mathematical theorem about prime numbers is only hinted at, Blansfield's reading that the play *Proof* is not about mathematics at all (Blansfield 7) is all too sweeping in that it misses major thematic aspects of the play and the film. One such feature of the stage as well as the screen version is the notable achievement to follow the complex discursive ramifications of the inspirational and emergent vis-à-vis the analytical and traditional (Alker and Davidson 173), or, to put it another way, of the domestic vis-à-vis the campus space. According to Alker and Davidson, spatial limitations traditionally confining women to the domestic sphere develop a paradoxical quality in math plays such as Stoppard's *Arcadia* and Auburn's *Proof* precisely because processes of marginalisation suddenly come to be seen as avenues for unorthodox, unconventional thought. For Alker and Davidson both playwrights

> challenge women's exclusion from and subordination within the male-dominated mathematical disciplines by suggesting that the marginalization of women, through historically limiting their access to education, or by expecting them to assume extensive travails of domesticity, paradoxically may have encouraged them to disrupt and recreate old mathematical models. (Alker and Davidson 172)

Granted that the domestic space is itself no obstacle to the genesis of a math play, Blansfield's dictum that *Proof* is not about mathematics might then seem to reflect the long-standing belief that the performance genres as such do not lend themselves as a privileged place to represent mathematical issues (Klaver 6). And yet, the playwright sought 'the advice of professional mathematicians and involv[ed] them in the rehearsal process' (Shepherd-Barr 131), an odd occurrence considering mathematics was not to play a role at all. Indeed, there are quite a number of 'meta-discursive "equation[s]' (Klaver 8) in *Proof* which put parts of the plot on a level with mathematical precedent. As has been previously pointed out, the exact nature of the mathematical proof remains a mystery, but Klaver's expectation that 'a performance can embed the decoding instructions of its subject matter within its own narrative' (ibid.) here unmistakably comes to life in the chronotopic reference to the French mathematician Sophie Germain and the primes named after her. It can be expected that every theatregoer or member of a film audience would have heard enough about prime numbers to at least identify them as ciphers of a mathematical phenomenon. Whether or not this would also include the correct definition is another question. The play and the metatextual film adaptation make full use of their respective techniques to relegate the proof's explanation to an ellipsis, a fictional place hidden from the audience. Thus in the play, when Hal, the young university mathematician, is about to illustrate the proof to Catherine's sister, the scene ends with a fade (Auburn 63). The film viewers are left waiting until the very last take, tellingly shot on a university campus, only to learn that the heroine will later talk her maths friend through the whole proof, hoping to improve it in the process (Madden 01:27:42-01:31:18). Catherine's intention to shorten the proof when explaining each step of the process to Hal, finally combines the two related aspects of aspired mathematical beauty and professional apprehension to verify her authorship, or, to put it in another way, it will be her double ability to explain the proof and revise it in the process which will then attest to her genius.

The question whether or not the mathematical proof is the heroine's achievement and not her father's is indeed the decisive issue in both play and filmic hypertext. The answer to the mystery of female agency very much relies on what we take to be a media-specific reading. The play's character constellation involves only four people and the spatial context is also very much reduced in that it is limited to the back porch of a house in Chicago. It follows that both character constellation and the unity of place serve as shorthand for semanticising the domestic which initially tends to be decoded as an obstacle to professional approval. Yet for more than two decades, and this is precisely Catherine's argument (Auburn 64), their house has been filled with mathematical table talk on game theory, algebraic geometry, and nonlinear operator theory. In a highly significant dialogue between Catherine and her father, who soon proves to be a ghost

haunting her mental performance space (Pizzato 130), the conversation suddenly turns to her depression, the time she has lost and, finally, to the natural number 1729.

> ROBERT: Catherine, if every day you say you've lost were a year, it would be a very interesting fucking number.
> CATHERINE: Thirty-three and a quarter years is not interesting.
> ROBERT: Stop it. You know exactly what I mean.
> CATHERINE: (*Conceding*) 1729 weeks.
> ROBERT: 1729. Great number. The smallest number expressible–
> CATHERINE: – expressible as the sum of two cubes in two different ways. […][2]
> ROBERT: You see? Even your depression is mathematical. Stop moping and get to work. The kind of potential you have – (Auburn 9)

Apart from the equation between depression and mathematics, this short dialogue illustrates a capacity for fast mental arithmetic and a telling acquaintance with the Hardy–Ramanujan number 1729. For those who are able to clear the chronotopic hurdle of the dramatic dialogue between father and daughter, the inbuilt reference to the natural genius of Srinivasa Ramanujan (1887–1920) definitely underpins Catherine's later self-introduction as the author of the proof. Her reliability as a largely self-taught mathematician with a near non-existent university education tends to increase every time the play adds another autodidactic authority to its chronotopic design. But even the structure of the dialogue under scrutiny here would seem to indicate a significant genetic heritage. In a noteworthy contrast to traditional antithetic half-lines,[3] the shared definition of the Hardy–Ramanujan number underscores the impression of a continuous mathematical agency from father to daughter. A reading that is also substantiated by the instructing circumstance that Robert's funeral coincides with the protagonist's 25th birthday, an anniversary that exactly corresponds to the stage in life when Ramanujan wrote his famous letter to the mathematician G. H. Hardy (1877–1947). Thus the playwright provides unmistakable clues at different levels of explicit or implicit marking. While the completion of the definition of the Hardy–Ramanujan number is a fairly obvious hint, the hidden reference to the identical age group of the Indian mathematician and his dramatic peer involves at least a modest knowledge of the history of mathematics.

It is obvious that when Catherine and Hal talk about the Germain primes (Auburn 30–31), she can again easily hold her ground in a mathematical debate (Shepherd-Barr 129). Yet Hal still assumes that the proof is the outcome of Robert's mathematical genius and he is only convinced when his fellow mathematicians, old and young, classify it as genuine, still rough in parts but definitely not the achievement of Catherine's father (Auburn 67–71). In the play the audience has to rely on just a few, yet chronotopically charged dialogues, the theatrical technique of the half-lines, on the male authorities and finally on Catherine's word that she worked on it after midnight to give the protagonist at least some credit for her accomplishment. Given the numerous cinematic cuts between real and memory spaces, Mark Pizzato assumes that 'the movie suggests more ambiguity about which notebook holds the proof of genius: Catherine's or Robert's' and he goes on to conclude that at least in the hypertext the heroine 'worked with her father to write her proof' (Pizzato 144–45). Admittedly, in the adaptation there is one

short living room scene in which Robert seems to provide a vital clue, when he almost effortlessly points to a Siegel zero, while still watching TV:

> CATHERINE (*who is not watching* TV): I figured out how to get a lower bound for L. … Modification of Landau-Siegel.
> ROBERT (*staring at the TV set*): What if this L had a Siegel zero? … You'd need an effective version.
> CATHERINE: (*Gazing at her father in surprise and awe*) Shit. (Madden 01:07:13-01.07:35; ellipses in the original)

Against the grain of Pizzato's view on the film's ambiguity, this article argues that the broader and more complex chronotopic design of the film foregrounds the idea of a largely self-taught genius, as was the case with Sophie Germain and later, the Indian mathematician Ramanujan. Not only do we actually see Catherine as a maths student at Northwestern University, we also witness her pertinent work at home as part of a complex narrative montage that covers the mathematicians' scrutinising the proof, her own sometimes epiphanic efforts when she suddenly becomes aware 'of the existence of a new dot' (Alker and Davidson 181) but also her father's meaningless graphomania. Here the film language as such proposes what amounts to a form of visualising female authorship. At the end of the kitchen scene, which we already know from the drama, Robert says, 'Stop moping. Do some work.' and places a notebook on the table (Madden 01:06:01-01:06:05). The following match cut then presents Hal with the notebook on his way to the Maths department where he puts it on a desk, turns it around and exhibits it to his colleagues. The continuity editing and the spatial quotation of the earlier scene leave the audience in little doubt that the proof is Catherine's.

Feminist criticism has taken issue with a conditioned happy ending that, as Schafer puts it, 'can occur only when the male authorities endorse the woman's work' (Schafer 9). Although Catherine appears to fit her fairy tale model of Cinderella when she has to prove that the object of scrutiny is hers, her Shakespearean namesake, the shrew, indicates that she has to partially submit to patriarchal dominance (ibid. 9–10) with just the discursive control of the final explanation left. And, above all, as was roughly the case with the explicitly mentioned prototype Sophie Germain, the heroine has to rely on the trustworthiness of her new friend. Initially, Hal is introduced as an ambivalent character who seems to have smuggled out one of Robert's notebooks. Catherine later even suspects that he could use the discovery of a new proof for his own advancement (Auburn 54), but then—in both the play and the film—he finally proves himself to be a trustworthy friend looking forward to Catherine's mathematical explanation, in the course of which she might even be able to improve the proof and make it more elegant, a feature that Brian Rotman primarily locates in the economy of means, when discussing the different manifestations of a beautiful proof (Rotman 157–58).

MENTAL ILLNESSES: MAD MATHEMATICIANS, FEMALE AGENCY AND THE FILM ADAPTATION

The contradiction between Catherine's alleged madness and her actual ability to perform high mathematics functions as a means of criticising the male-dominated space of science. The chronotopic frames which particularly refer to other film genres such

as the *mind-game movie*, the *paranoid woman's film* or the *zombie film* serve as 'decoding instructions' (Klaver 8) to the mystery of Catherine's mental condition and her status as a female mathematician who demands professional recognition. The hypertext ironically subverts the negative stereotype of the mad and paranoid woman who has lost her mind, by juxtaposing certain film techniques and film images with visualisations of a daughter perfectly capable of matching her father's ingenuity.

The 'mad mathematician' remains a predominant stereotype, but how does this chronotope reveal itself on the film screen? With regards to maths and mental illness, one cinematic example looms large: Ron Howard's *A Beautiful Mind* released only four years before Madden's *Proof*. Nash was a genius in the field of game theory, but at the same time he suffered from paranoid schizophrenia which he was able to overcome. *A Beautiful Mind* carries the association of maths and mental illness to extremes, presenting a highly paranoid mathematician with imaginary friends and hallucinations about a mysterious Pentagon endeavour in which he thinks he is involved. In addition, the fictitious Nash suffers from periods of graphomania—a disturbing habit Robert equally demonstrates in *Proof*. It thus seems reasonable to assume that audiences familiar with *A Beautiful Mind* perceived the film *Proof* with this very chronotopic reference in mind. Furthermore, Nash's second son was likewise diagnosed with schizophrenia (Faulkner 211). The question whether this mental illness is hereditary constitutes one of the key issues discussed in both the play and the film.

It is without doubt that both Robert and Catherine have mental health issues, although their actual condition is not made explicit in either the play or in the film. The aforementioned chronotopic reference to John Nash and Howard's related biopic, however, confirms a reading that at least Robert suffers from schizophrenia and Catherine thus might have inherited the disease. According to her descriptions in the film, Robert 'read all day,' 'believed aliens were sending him messages,' 'used to shuffle around,' 'talked to himself,' 'stank,' and needed assistance in every-day activities (Madden 00:24:53-00:28:35). He also demonstrated graphomaniac habits and demanded hundreds of notebooks, 'convinced that he was writing the most beautiful proofs' (ibid.). These behaviours combined with those displayed in other film scenes in which Robert shows signs of memory loss, is inappropriately dressed, or has emotional outbursts, can all be part of a schizophrenic disease. The same symptoms, however, including graphomania, also hold true for mental illnesses such as dementia, a brain disease not believed to be as hereditary as schizophrenia (Picchioni and Murray 333–335, Can et al. 336–39). Taking contemporary psychiatric discourses into consideration, the nature of Robert's mental disease thus cannot be clearly determined. Furthermore, the only characters who suggest that Catherine might have inherited her father's disease are herself and her sister Claire. Robert, by contrast, calls his daughter simply depressive in both play and film, albeit playfully as he refers to her mathematical abilities (Auburn 9–10, Madden 01:05:50). In our opinion, what is especially striking is the seemingly unproblematic credibility of a mad man—Robert—performing high mathematics, despite his mental anomalies which already occurred in his mid-twenties (Madden 00:04:20), whereas Catherine's abilities as a female mathematician and alleged heir of her father's mental disposition are under constant scrutiny.

The opening sequence of the filmic metatext (Madden 00:00:00-00:07:04) differs significantly from the first act of Auburn's play. While the drama directly begins with Catherine and Robert's conversation about their mental condition and mathematics outside their house on a porch, Madden's film commences with a medium shot of rain running down windowpanes, already evoking a gloomy and depressed atmosphere. After the camera slowly pans to the right, it gazes into a living room where a TV set is showing advertisements the content of which ranges from eye cream, to stain remover, to weight loss, and real estate. These images already fix the protagonist firmly in the domestic space traditionally connoted female as she has chosen to care for her father instead of attending university. The camera then cuts to a close up of a hand holding a remote control and shortly after to Catherine sitting in a chair, looking clearly depressed as her lethargic posture and vacant stare reveal. The TV ads related to body care already allude to a person who has let herself go and is both physically and mentally out of shape. On the one hand, Catherine's constant and random zapping through seemingly trivial TV ads appears to underpin the reading that she has lost interest in the external world. On the other, it is she who is holding the remote control, reinforcing the ambiguity of her mental state oscillating between autonomy and heteronomy. What we see here in any case is not a passionate Viola (Paltrow), full of joie de vivre, who we know from Madden's *Shakespeare in Love* (1998), but rather a passive damsel in distress who needs to be rescued from her depressed state of mind. Indeed, Paltrow, in the role of Catherine, can clearly be seen as the result of an off-casting process (Fiebig and Klohs 231). After a series of flashbacks to the days she visited her father on campus, she supposedly wakes up to Robert's question 'can't sleep?' (Madden 00:07:04).

As the film audience only learns at the end of the sequence, Robert is, in fact, already dead. What are the spectators witnessing here—one of Catherine's memories produced by her deep grief over the loss of her father? Or is Robert part of a schizophrenic hallucination? Is she just mourning or perhaps even suffering from severe depression? In one of his seminal texts, Sigmund Freud describes melancholia—an outdated term for depression—as 'pathological mourning' (Freud 250). While both conditions (mourning and melancholia) manifest in the patient's 'painful dejection' (ibid. 244) and 'loss of interest in the outside world' (ibid. 245), the profound self-criticism and violent self-accusations so typical of depression are absent in mourning (ibid. 244–48). Undoubtedly, Catherine also has no interest in the outside world when she lethargically watches TV in the opening sequence. However, she later claims to have written the proof, an assertion requiring strong self-confidence which seems to lead to a contradiction between her alleged mental instability and her abilities as a mathematician. Catherine's mental state remains unclear in this scene: Robert's appearance might be either read as a hallucination triggered by schizophrenia, or just as a result of Catherine's (normal) cathectic mourning process in the form of a wishful prolonging of his existence visualised by flashbacks. The latter interpretation is just as plausible here when taking the very close father–daughter relationship into consideration. In our view, the question whether she suffers from schizophrenia, depression or is just mourning is quite irrelevant; what looms large is the contradiction between an alleged 'mad woman', who—according to the negative stereotype pointed out earlier with recourse to Cristina Wald's research—cannot possibly perform high mathematics, and the actual visualisation of her working

together with her father. This discrepancy is triggered mainly by genre-related chronotopes as will be discussed shortly. We will first revisit the deception of the film audience in terms of Robert as this device already opens up a particular chronotopic dimension.

Shepherd–Barr emphasises that it is especially Auburn's 'great dramatic trick' (Shepherd–Barr 130) of introducing Robert as a real character which in hindsight raises the question of whether Catherine's conversation with her deceased father is a symptom of her mental illness. Used in the filmic hypertext, however, this 'mind-game' induces a certain intertextual chronotope, namely the strategy Ron Howard exploits to the fullest in *A Beautiful Mind*. As Thomas Elsaesser points out, the audience is fooled by this 'narratological puzzle,' suspending 'the common contract between the film and its viewers which is that films do not "lie" to the spectator' (Elsaesser 19). We feel betrayed by the images and automatically suspect Catherine of distorting her and thus our 'reality'. Here, the reference to the historical John Nash as well as Howard's mind-game film contribute to Catherine's status as an unreliable narrator. Although this deception of the audience remains the only incidence in the hypertext, Catherine is, in fact, associated with insanity until the end of the film, despite the acknowledgement of her authorship. At no point does the film text fully avert the suspicion that Catherine inherited her father's disease. Hence, the question remains what kind of analytical potential the adaptation opens up in the context of a gender-oriented approach by linking mathematicians and madness. While Klaver points to the general 'skepticism of women's mathematical ability' (Klaver 6), we would like to take up a further consideration by Elsaesser with regards to the mind-game film. He addresses the so-called '*paranoid woman's film*' (Elsaesser 25), a genre most popular in the 1940s. These films present women who 'are driven insane by husbands whom they no longer think they can trust […], until they are rescued by another male, usually younger and more "modern", but male nonetheless' (ibid. 23). Mark Jancovich stresses the pathologisation of the psychology of these women who can only be saved 'if a man comes to the rescue and corrects' their experience (Jancovich 2nd paragraph). Therefore, the mystery of these films mainly focuses on the female's problematic mental state which requires correction by a male partner (ibid. 5th paragraph). This genre-related chronotope is also hinted at in the adaptation of *Proof*. Hal is the partner Catherine thinks she cannot trust until he evolves into her saviour. He rescues his damsel in distress from the domestic sphere of her father by (re-) introducing Catherine to the male domain of mathematics on campus in the second part of the film. What role does insanity play in this context though? Regarding the 'paranoid woman's film', Elsaesser adds that paranoia also has a productive quality as it not only evokes a high creative potential but can further be read as 'a response to the crisis in subject-formation' (Elsaesser 26). He calls these 'productive pathologies'—in a Foucauldian sense— "micro-politics of power" as they shed light on identity crises and thus open up spaces of agency (ibid. 31–32). Applied to the problem of madness, maths and female agency, it is safe to say that the very depiction of Catherine's alleged insanity, evoked by the genre-related chronotopes of the hypertext, serves as a critique of the male-dominated sphere of mathematics. In other words: Her seemingly inappropriate behaviour can be read as a subconscious reaction to patriarchal structures, not only prevalent in the sphere of mathematics, but in society in general as she is cast back into the domestic sphere. Hence, the mystery of Catherine's mental state represents the very

potential of both the drama and the film version of *Proof* to criticise traditional gender constructs. The cinematic adaptation of this play, however, has a metatextual advantage over the dramatic hypotext as it is able to unobtrusively include references to other films and genres. The following film scene (Madden 01:06:31-01:07:24) illustrates this strategy in a striking manner.

The scene begins with Claire knocking on Catherine's door; she then enters before receiving a reply. The camera shoots Catherine using a close-up of her face, lying lethargically in bed while her sister touches her shoulder and gently but quickly asks "Catherine"? A match cut follows from the heroine's face to a face of another woman in a black and white film on a TV screen looking terrified. As the subsequent shots of this co-present film reveal, the woman is being chased by a man moving abnormally who then manages to hide inside a house. The camera cuts to Catherine and Robert sitting on a sofa together. While Robert is watching TV and eating popcorn, Catherine is engrossed in her maths notes and then she starts a conversation about the previously mentioned Landau-Siegel zeros with her father. The scene concludes with a repeated straight cut to the TV screen that displays the terrified woman in the uncanny house in which she has sought shelter, shortly followed by a close-up of Claire sealing up moving boxes. What the film audience witnesses here, as a genre-related chronotope, is a scene from George A. Romero's zombie film, *Night of the Living Dead* (1968). Romero's *Night* features the character Barbara who hides in an abandoned farmhouse after being attacked by a zombie. Barbara is in a helpless catatonic state once she enters the house (Jancovich 5th paragraph). As Kyle Bishop adds: "[she] can do little more than sit and stare" while the film's male hero quickly turns the house into a fortress (Bishop 203). Harper stresses that Barbara's terrified catatonic state and silent submissiveness is not just a reaction to the zombie attack(s) from outside, but is also a result of male aggression and thus patriarchal domination inside the house (Harper 6th paragraph). The author concludes that Barbara's mental instability renders *Night* a feminist film as it criticises patriarchal attitudes and actually functions "as a satirical comment on traditional representations of women" (ibid.). How does this tie in with a reading of *Proof*'s female protagonist? At first glance, Catherine's status as a supposed mad woman can likewise be read as a revolt against patriarchal structures within the sphere of maths. She is portrayed in a similar mental state as Barbara, particularly in the opening sequence of *Proof*, and her mental condition is repeatedly under debate throughout the whole film. Moreover, Catherine not only has to face ("masculine") resistance from outside, i.e., the campus space, but also ("feminine") obstacles from within the domestic sphere.[4] Nevertheless, a closer look at the link between the *zombie film* or *Night* and *Proof* reveals that Barbara and Catherine seem to share certain characteristics. Yet the TV scene in particular also ironically subverts Catherine's status as a paranoid and passive female. Unlike Barbara, Catherine does more than just "sit and stare" on the couch. On the contrary, she sits and does maths with her father while completely ignoring the TV screen. This is also reflected in the position of her body which is turned away from the television set. What she is interested in is her maths which she actively, not passively, performs in her notebook. By juxtaposing the genre-related chronotope of the *zombie film* with a young woman doing mathematics, the scene ironically comments on

persisting stereotypes, not only with regards to women in the domestic space, but especially in the world of mathematics, as emphasized by Christina Wald.

The appearance of her dominant sister Claire, however, frames the TV scene and equally functions as a threat to Catherine's mathematical as well as personal agency. Claire's intrusion into her sister's room at the beginning of the sequence and the close-up of her sealing up the packing cases for their move to New York at the end show both her ambition to drive her sister away from her home and even move her into a psychiatric ward as well as an attempt to reduce Catherine to silence, visualised by the packing tape she uses for the boxes. As a result, Claire represents a threat from within the domestic sphere, also reflected in the intertextual film quotation of Romero's *Night*. Barbara's terrified look outside and inside the farmhouse thus expresses the resistance and dangers Catherine has to face from the campus space and the domestic sphere. This leaves us in little doubt that Madden's *Proof* skillfully blurs the lines between mathematics, mysteries, and mental illness.

In fact, the mystery of Catherine's sanity, intensified in the cinematic metatext by film and genre quotations, is the critical essence of *Proof*. The more the film text plays with the question of the heroine's sanity, the more it functions as a critique of power structures within the field of mathematics and its agents. The genre-related chronotopes of the *mind-game film*, the *paranoid woman's film* and especially the *zombie film* ironically enhance the contradiction between an apparently mad female and a woman actually performing high mathematics. Even more, this very discrepancy highlights the negative stereotype that mad women cannot possibly be brilliant at the same time, whereas the (male) mad mathematician is firmly established in our cultural memory and thus taken for granted. Indeed, as Sarah Juliet Lauro and Karen Embry emphasise, "the zombie [as a metaphor] can be made to speak only as a somewhat ironic discursive model […]; thus it calls […] for the destruction of the reigning model" (Lauro and Embry 91). Here, the power relations of the campus and the domestic sphere are about to be "destroyed" precisely because the mystery of Catherine's sanity is liable to question existing hegemonies within the world of mathematics.

CONCLUSION: PROVING THE FEMALE AUTHORSHIP OF THE MATHEMATICAL PROOF

The two versions of *Proof* no doubt endorse the view that mathematics and its agents are deeply mysterious. But the two media are not alike in the readings they seem to suggest in terms of Catherine's mental stability. Whereas the play equally operates with flashbacks and thus evokes mind-games in order to question the protagonist's state of mind, the adaptation makes use of different references, rapid changes of location, as well as visual metaphors which enhance the ambiguity about her mental health. What can be said in terms of both media, however, is that varying character configurations, the often unexpected juxtaposition of real or mental performance spaces, the inbuilt rivalry between the domestic and the academic terrain, and the different chronotopic frames, all contribute to what can be called a media-related questioning of the heroine's claim to authenticity in the face of a predominantly male maths circle. Given the essay's analytical triple focus on mathematicians, mysteries, and mental illnesses, their partial overlap as well as their chronotopic embedding, the comparison between

the media points to two major results. First, compared to the play, the filmic hypertext tends to be slightly more conclusive in favouring Catherine as the likely author of the title's proof and it does so mainly using supportive continuity editing and the specifics of a Bakhtinian texture or, more precisely, its spatio-temporal design. In contrast to the dramatic hypotext, the metatextual adaptation provides additional clues to solve the mystery of female authorship, while not attempting to formulate an overly simplistic critique of the play. Thus, in terms of the question of authorship, the propositional difference between the two media becomes a matter of degrees and not an issue of rival statements or readings. Second, it is again the adaptation that pays more attention to Catherine's mental instability. Here, the complex chronotopes such as genre- and concrete film-references and an unstable narrative reliability create both ambivalent scenes as well as blanks. Against the backdrop of the question of female authorship, we conclude that it is precisely the close interdependence between mysteries and mental illnesses that highlights and, at the same time, ironically subverts gender-biased stereotypes of (mad) mathematicians. By way of developing this thesis, this paper clearly shows that it is the prerogative of textual and filmic hermeneutics to finally reconcile flashes of mathematical genius with detrimental moments of mental instability, an intellectual endeavour that boldly attempts to operate at eye level with the logic of any sophisticated proof.

NOTES

[1] Of course, mathematics is not the only area in which women have to face a predominantly male discourse. In the corresponding field of research, Shelley Cobb's study *Adaptation, Authorship, and Contemporary Women Filmmakers* (2015) is an excellent contribution that "foregrounds the figure of the woman author [who] functions as both a representative of female agency and as a vehicle for representing the authorizing of the woman filmmaker" (Cobb 1). Although it is related to female *filmmakers* and the level of *production* rather than our concept of "female authorship" in terms of the origin of a mathematical proof, it supports the general claim that women still have to defend their abilities and expertise in a patriarchal society.

[2] These are the two different ways: $1729 = 1^3 + 12^3 = 9^3 + 10^3$.

[3] The technical term is hemistichomythia.

[4] Although we wish to avoid stereotypical gender oppositions such as 'masculine' vs. 'feminine' in relation to the 'domestic' and 'campus space' we aim at a strategic essentialism in order to demonstrate the various threats Catherine has to face from outside and within the domestic sphere.

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