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Aspects of Newtonianism in Rameau's Génération harmonique

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A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Music

Aspects of Newtonianism in Rameau's *Génération harmonique*

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by

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Abstract

This dissertation studies the influence of Newtonianism as a cultural phenomenon on the theoretical writings of Jean-Philippe Rameau (1683-1764). Rameau's *Génération harmonique* (1737) shows a change in his thinking from his earlier work that bears witness to the debates around Newtonian science in the scientific community. Scholars have discussed possible connections between *Génération harmonique* and Newton's *Opticks* (1704) but none has studied this issue in detail. I argue that Rameau was influenced by Newtonianism rather than by Newton's works, and that Rameau was not always aware of this influence. In order to situate Rameau's work within the larger body of Newtonian works, I have compared it with Newton's writings as well as other scientific texts of the early eighteenth century.

First I provide a background on Newtonianism and its central figures, focusing especially on Voltaire's *Lettres philosophiques* (1734) and the scandal surrounding its publication. I discuss Rameau's use of experiments to demonstrate his concept of the *corps sonore* (the resonance of a vibrating body) and the connection between these experiments and other scientific works of the time. These experiments were based largely on the work of Dortous de Mairan (1668-1771) and can be understood as a part of Rameau's attempt to gain status inside the *Académie royale des sciences*. Next I study Rameau's use of certain terms that strongly resonated with Newtonian physics, especially as Voltaire had popularised it. Rameau's use of these terms can be understood as his attempt to gain social status outside of the *Académie* by aligning his work with popular scientific works of the time. Finally, I consider the lack of Newtonian influence on Rameau's works written after the 1730s. I interpret Rameau's removal of Newtonian concepts and methods as a reflection of his larger goals to gain social status and to elevate music theory to the level of prestige accorded to the sciences. From his later works we can see that he used scientific methods and ideas

opportunistically. Studying Rameau from this perspective situates his work within larger trends in Enlightenment science and demonstrates how music theory can be seen as a cultural product.

Keywords

Newtonianism, Rameau, Voltaire, Castel, Fundamental Bass, *Corps Sonore*, Experience, Enlightenment, Science, Music Theory

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Chapter 1: Introduction and Overview

As a composer and organist, Jean-Philippe Rameau (1683-1764) was renowned as the best musician in France. Rameau, however, was never satisfied with this reputation. Recent scholarship has suggested that Rameau sought to create a reputation for himself as both a musician and a philosophe (the eighteenth-century French term for a learned man of letters). From his theoretical works—*Traité de l'harmonie* (1722), *Nouveau Système de musique théorique* (1726) and *Génération harmonique* (1737)—it is evident that Rameau sought to elevate music theory to the level of prestige accorded to the sciences. His work references prominent philosophers and mathematicians of his day, such as Joseph Sauveur (1653-1716), and Dortous de Mairan (1668-1771), as well as the work of René Descartes (1596-1650). While Rameau never stated his scientific aspirations outright, they are apparent from his multiple attempts to become a member of the Parisian *Académie Royale des Sciences* (hereafter, the Academy) as well as Academies in other regions. While his desire to become a scientist and to have his work respected in these terms is evident, readers are left to wonder how and why Rameau went about his scientific endeavors. My study of Rameau's works in the context of French Newtonianism reveals what Rameau had to gain from creating such a public reputation. I examine his strategies for promoting his work in a scientific light, and I suggest reasons why this would have been the most appealing mode of self-promotion available to Rameau in the 1730s.

This first chapter contains an overview of the topic and central arguments, followed by a review of secondary literature related to Rameau and his theory of

harmony as well as other cultural studies of the Enlightenment. At the end of the chapter I have included summaries of the following four chapters.

Overview of the Topic: Rameau and Newtonianism

Several scholars have suggested that Rameau's *Génération harmonique* (1737) was influenced by Isaac Newton's *Opticks* (1704).[1] As Rameau's earlier writing has been described as "Cartesian,"[2] scholars often suggest that Newton's influence marks a shift in Rameau's thought. Musicologists and theorists who discuss this issue have not always distinguished between Newton and Newtonianism, such that their claims concerning Newton's influence have been overstretched. Authors such as Thomas Christensen, Raphaëlle Legrand, and Joel Lester who claim a connection between Rameau and Newton do not present sufficient evidence of such a relationship between Rameau's and Newton's work. Still, the format and tone of Rameau's *Génération harmonique* contrast with the writings that precede it, specifically *Traité de l'harmonie* (1722) and *Nouveau système de musique théorique* (1726), indicating some change in his thought.[3] I argue that Rameau's work was shaped by Newtonianism, a cultural phenomenon that emerged in France during the early eighteenth century, rather than by Newton himself. Reading Rameau's works through a Newtonian lens demonstrates that the change in his

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[1] See Thomas Christensen, *Rameau and Musical Thought in the Enlightenment* (Cambridge: Cambridge University Press, 1993) 141-49 and 185-90; Raphaëlle Legrand, *Rameau et le Pouvoir de l'Harmonie* (Paris: Cité de la Musique, 2007), 34-35. Joel Lester, *Compositional Theory in the Eighteenth Century* (Cambridge, MA: Harvard University Press, 1992), 127-8.

[2] Christensen, *Rameau and Musical Thought in the Enlightenment*, 11-15; Lester, *Compositional Theory in the Eighteenth Century*, 91-92.

[3] Hereafter I will refer to these works as *Traité* and *Nouveau système*.

perspective in the 1730s was not so much the result of Newton's direct influence as it was part of Rameau's ongoing attempt to gain recognition from the contemporary scientific community and especially from the Academy.

The specific source of Rameau's knowledge of Newtonianism cannot be known, as Rameau never cited a specific work or individual. My concern is not to engage with this issue. Rather, I attempt to situate *Génération harmonique* in an intellectual milieu that included Newtonianism, an idea that I will confront in the following chapters. I find reading Rameau through a Newtonian lens to be useful, because it is a lens that many of his original readers might have employed, and because it can tell us much about the relationship between the histories of music theory and science.

I define Newtonianism as a cultural phenomenon in France that gained momentum in the early eighteenth century and resulted in a series of intellectual disputes in the 1730s.[4] Newtonianism can be understood in part as the dissemination and acceptance of Newton's work in France. However, as a cultural phenomenon, it distorted Newton's actual work in several ways. A theological dimension in Newton's writings was emphasized when discussed in French periodicals, meaning radically religious interpretations of gravitational attraction were more prominent in France than in England.[5] Also, French journalistic accounts of initial debates over Newtonian physics tended to sensationalize their discourse so as to imply that these arguments had been more personal and insulting than they truly were. J. B. Shank argues that when Newton's theories reached the continent, Newtonianism arose as an intellectual movement separate

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[4] My understanding of Newtonianism in this socio-cultural sense is based on J. B. Shank, *The Newton Wars* (Chicago: University of Chicago Press, 2008).

[5] Ibid., 131.

from Newton himself.[6] Further, Voltaire (1694-1778) was one of the few self-identified French Newtonians in the early eighteenth century, and historians frequently credit him with disseminating Newtonianism in France after his exile in England. It is useful to remember that Voltaire's Newtonianism is only one version of Newtonianism, in that Voltaire focused on aspects of Newton's work that made Newton seem heroic in order to capitalize on that image for his own public persona. As Voltaire's brand of Newtonianism became prominent in France, French Newtonianism became synonymous with the characteristics that were most important to Voltaire.

French Newtonianism includes the following characteristics: a new enthusiasm for experimental science; an interest in the theory of gravitational attraction, especially as the source of all motion in the universe; an interest in the corpuscular theory of light, as outlined in Newton's *Opticks*; a corresponding interest in corpuscular theories of sound, such as Mairan's; accessible presentations of Newton's ideas, stripped of their mathematical formulas and aimed at general readers; the mediation of intellectuals advocating for Newton and his theories, rather than the influence of Newton's works themselves. As Shank discusses, a series of political and scientific debates centered around Newtonianism in France, especially after 1730, as Pierre Louis Maupertuis (1698-1759) and Voltaire drew attention to Newton's ideas. Shank describes the scope of Newtonianism as,

> an entanglement of all the hot-button topics of the day – science, nature, experiment, materialism, Spinozism, radical religion, publicity, and politics, among others.[7]

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[6] See especially Shank, *The Newton Wars*, Ch. 1: "Newton without Newtonianism," 49-104.

[7] Ibid., 163.

The "Newtonian" label became a political identity among scholars who identified themselves in opposition to Cartesianism, though neither term actually designated a fully unified body of scholarship or intellectuals. Furthermore, as Newtonianism gained in popularity, the labels "Cartesian" and "Newtonian" became even more problematic, as many "Cartesians" were interested in certain aspects of Newton's theories, while "Newtonians" for their part maintained some Cartesian affinities. While these debates ostensibly centered on whether Newton's understanding of celestial mechanics could replace Descartes's, they also took on political and nationalistic overtones. French resistance to Newtonian physics was tied, in part, to the newly perceived threat of English science to the existing authority of French science.[8]

Newtonianism gained traction in part because of the great number of Newtonian works aimed at non-expert readers. Newton's *Opticks* began this trend, as it presented his theories of light and gravitational attraction in less technical language and without the complicated mathematics of his earlier *Philosophiæ naturalis principia mathematica* (1687). The many other Newtonian publications that followed, including the 1738 treatise *Le Newtonianisme pour les Dames* (published in French in 1738[9]) by Francesco Algarotti (1712-1764), demonstrate the extent of the popular audience for Newtonian science when it was presented in accessible language. As Sarah Hutton writes, "the Newtonianism of

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[8] Ibid., 48. Shank points in particular to the work of Privat de Molières, who believed that by the late 1720s, French mechanical science had been "challenged" by scientists from other countries.

[9] Francesco Algarotti, *Le Newtonianisme pour les dames*, 2 vols., trans. Duperron de Castera (Paris, 1738).

popular consumption was 'soft' Newtonianism."[10] My claim is that Rameau was influenced by soft Newtonianism and not by Newton's works. It is not impossible that he read Newton's works, but *Génération harmonique* betrays the influence of popular Newtonianism. The presence of Newtonianism in Rameau's work is most noticeable in his manner of presentation, as he used certain terms and ideas associated with Newtonianism to frame his theories during the decade when Newtonianism was most controversial. After the 1730s, the Newtonian aspects in Rameau's writings significantly waned. Other kinds of scientific underpinning nevertheless continued in Rameau's later theoretical works.

French journalism also underwent significant changes in the early eighteenth century, including a new appetite to engage in heated debates or even open arguments.[11] Thomas Broman lists numerous newly created periodicals among the new forms of social engagement in France during the early eighteenth century. During this time, public discourse began to center around criticism, whether of art, scientific thought, religious institutions, or the state.[12] Broman notes that while these discussions were ostensibly open to anyone, in effect they excluded most members of society other than educated men. They were perceived, however, as providing a sort of egalitarian space for members

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[10] Sarah Hutton, "Women, Science, and Newtonianism: Emilie du Châtelet versus Francesco Algarotti." In *Newton and Newtonianism: New Studies*. Edited by James E. Force and Sarah Hutton (New York: Kluwer Academic Publishers, 2004), 185-7.

[11] Shank, *The Newton Wars*, 105.

[12] Thomas Broman, "The Habermasian Public Sphere and 'Science *in* the Enlightenment,'" *History of Science* xxxvi (1998), 126. Broman draws on Habermas's understanding of the public that emerged during the Enlightenment, especially his work, *The Structural Transformation of the Public Sphere*, trans. Thomas Burger and Frederick Lawrence (Cambridge, MA: MIT Press, 1989).

of the public to voice their thoughts.[13] Collectively, these forms of discourse created a new sense of a public sphere that was independent from the State, even though the government maintained some control over publishing.[14] Newtonianism in France thus emerged during a period of significant change in public discourse.[15]

The writings of Louis Bertrand Castel (1688-1757) stood out in this period for their heated rhetorical style. Castel edited the *Journal de Trévoux* from 1722-1745 and frequently engaged in polemics with other intellectuals, including Voltaire and Rameau.[16] Castel's polemic with Rameau is typical of these disputes, as the content quickly turned from criticisms of his harmonic theory to ad hominem attack. Not only was Rameau's revised harmonic theory conceived during this time of increased public contestation, Rameau himself engaged in such debates and consistently responded in kind to criticisms of his work. In fact, Rameau was well known for publically repudiating his detractors, many of whom were initially his supporters. The public criticisms of writers like Jean le Rond d'Alembert (1717-1783), Denis Diderot (1713-1784), and Castel often ended Rameau's relationships with prominent intellectuals who had once supported his theoretical endeavors.

I argue that Rameau's harmonic theory reflects the influence of cultural Newtonianism and that he likely believed that adopting certain new elements into his

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[13] Ibid., 127

[14] Ibid. 125-128.

[15] Shank, *The Newton Wars*, 163.

[16] Cyril B. O'Keefe, *Contemporary Reactions to the Enlightenment (1728-1762): a Study of Three Critical Journals, the Jesuit* Journal de Trévoux, *the Jansenist* Nouvelles ecclésiastiques, *and the secular* Journal des Savants (Genéve: Slatkine, 1974), 35. The *Journal de Trévoux* was one of the only periodicals to strongly censure Voltaire for *Lettres philosophiques*. I return to Castel's relationship with Voltaire in Chapter 4.

theory would have helped him to create a public persona as a philosophe. Throughout his career, Rameau sought approval from and membership in elite academic societies, including the Academy in Paris. Given the significance of the Academy in French intellectual culture, it is understandable that Rameau would have attempted to become an Academy member.[17] Rameau initially petitioned their approval by dedicating of *Génération harmonique* to the Academy.[18] Christensen also notes that Rameau solicited support from prominent Academy members such as Mairan and d'Alembert, and that Rameau sought approval for *Nouveau système* from the British Royal Society.[19] Having failed to achieve Academy membership with his earlier works, Rameau presented a version of his 1750 treatise, *Démonstration du principe de l'harmonie*, to the Academy in 1749, and finally received their approval.[20] However, he was never granted membership in their organization. From his many attempts to gain Academy membership and support from prominent intellectuals, we can see that Rameau sought this status throughout his life and used whatever means he deemed appropriate.[21] In the 1730s, the

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[17] For more on the *Académie royale des sciences*, see: Albert Cohen, *Music in the French Royal Academy of Sciences: A Study in the Evolution of Musical Thought* (Princeton: Princeton University Press, 1981); and Alice Stroup, *Royal Funding of the Parisian Académie Royale des Sciences during the 1690s* (Philadelphia: American Philosophical Society, 1987).

[18] Jean-Philippe Rameau, *Génération harmonique* (Paris: Prault Fils, 1737), i-ii; Deborah Hayes, "Rameau's Theory of Harmonic Generation: An Annotated Translation and Commentary of *Génération harmonique* by Jean-Philippe Rameau." Ph.D. diss. (Stanford University, 1968), 14-15.

[19] Christensen, *Rameau and Musical Thought in the Enlightenment*, 10-11.

[20] Ibid., 11.

[21] For more on Rameau's attempts to receive scientific recognition and Academy membership, see: Christensen, *Rameau and Musical Thought in the Enlightenment*, 10-11; Hayes, "Rameau's Theory of Harmonic Generation," 284-86; Roger Lee Briscoe, "Rameau's *Démonstration du principe de l'harmonie* and *Nouvelles réflexions de M. Rameau sur sa démonstration du principe de l'harmonie*: An Annotated Translation of Two Treatises by Jean-Philippe Rameau" (Ph.D. diss., Indiana University, 1975), 10-11, and 49-52.

popularity of Newtonianism meant that experimentation and the rhetoric of attraction were obvious means for Rameau to promote his theories as a science. The characteristics of French Newtonianism (use of experiments, empirical studies of nature, gravitational attraction) seemed to support Rameau's revised harmonic theory as it had progressed since *Traité* and *Nouveau Système*.

Rather than showing that Rameau was influenced specifically by Newton, I argue that we can understand *Génération harmonique* as entangled in and bearing the influence of French Newtonianism. On one hand, I argue that Rameau self-consciously adopted experiments and other new concepts that would closely tie his work to the work of other French scientists who were identified as Newtonians. On the other hand, I argue that he was not aware of the negative reactions his work would spur and the professional difficulties that an association with Newtonianism would bring him. Had Rameau not sought to connect his theories to popular works of experimental science, it is possible that the older members of the Academy would have looked more favorably on his work, and that reviewers would not have reacted so harshly.

The influence of cultural Newtonianism can be seen in *Génération harmonique* in two primary ways. First, Rameau drew on the work of Mairan who had adapted Newton's theory of corpuscular light to theorize corpuscular sound. Rameau's use of Mairan's methods to create his own closely tied his work with Newton's, as his reviewers easily connected their ideas. Second, Rameau revised the language with which he theorized the role of the subdominant and the *double emploi* in such a way that it strongly echoed writings on gravitational attraction, such as Voltaire's *Lettres philosophiques* (1734)[22].

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[22] Voltaire, *Lettres Écrits de Londres sur les Anglois et autres Sujets* (Paris, 1737).

Voltaire's *Lettres* serves as a fitting example for comparison because Voltaire's version of Newtonianism was primarily associated with gravitational attraction. While other Newtonian scientists focused on issues of experimentation, the shape of the earth, or corpuscular theories of light, Voltaire was best known for his discussion of gravity. I do not claim that Voltaire directly influenced Rameau's harmonic theory. Rather, his *Lettres* was among the best known and popular works on gravity at the time, and it influenced subsequent texts on the same topic. Any influence would thus have been very indirect.

However, it is possible that Voltaire's use of Newtonianism to elevate his social status would have appealed to Rameau. Shank argues that Voltaire used Newtonianism to create a persona as a philosophe:

> Maupertuis and Voltaire set the pattern through their parallel use of Newton to open a critical cultural space between establishment French science (i.e., the Royal Academy) and the wider French public.[23]

He goes on to say,

> By positioning himself as a nonacademic authority on natural philosophy, and by using that position to imply a challenge to the official scientific establishment, Voltaire in effect defined a new conception of the man of letters as an independent, critical thinker beholden only to universal reason and the public that authorized [this conception].[24]

I believe this identity as an independent intellectual would have been attractive to Rameau, as he constantly sought status for himself and his theories within the Academy, but was never quite able to achieve this. Using ideas from experimental science (which was associated with Newtonianism) would have given Rameau's theories an alternative source of legitimacy.

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[23] Shank, *The Newton Wars*, 243.

[24] Ibid.

While other scholars have sought a historical context for Rameau with regards to Newtonianism and Cartesianism, [25] my study positions him and *Génération harmonique* more specifically within the Newtonian debates of the 1730s. Christensen gives a detailed picture of Rameau in relation to Enlightenment philosophy but does not fully account for the nuances of each side of the contemporary debate over Newtonianism (and, in fairness, this is not the goal of his book). According to Shank, the divisions between "Cartesian" and "Newtonian" were messy, and understanding who was inside and outside the Academy was never a straightforward matter. Philosophical influences on Rameau's writing, especially in *Génération harmonique*, are similarly messy and have not been fully explored.

I suggest that many Rameau scholars have been somewhat cavalier in connecting Rameau to Newton. For example, Christensen too easily draws connections between Rameau's theory and Newton's *Opticks*. While I agree with Christensen's general observation, I will argue in a later chapter that the influence of *Opticks* on *Génération harmonique* was subtler and rather indirect. Additionally, many of the examples of Newtonian language that he takes from *Génération harmonique* also appear in *Nouveau système* from eleven years earlier. Legrand similarly draws a connection between Rameau and Newton without pointing to any specific evidence.[26] Joel Lester refers to Newton's ideas as a part of the intellectual climate of the eighteenth century and says that

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[25] In *Rameau and Musical Thought in the Enlightenment*, Christensen situates Rameau within a broader Enlightenment context that includes Cartesianism and Newtonianism but does not deal with any one perspective in extensive detail. See also: Scott Burnham, "Method and Motivation in Hugo Riemann's History of Harmonic Theory," *Music Theory Spectrum*, vol. 14, no. 1 (Spring, 1992): 1-14; and Brian Hyer, "Before Rameau and After," *Music Analysis*, vol. 15, no. 1 (March, 1996): 75-100.

[26] Legrand, *Rameau et le Pouvoir de l'Harmonie*, 34-55.

Rameau became the "Newton of music," as he privileged experience alongside reason, though Lester does not give any evidence of Rameau's knowledge of Newton.[27]

Further complicating the Newtonian issues in Rameau's work, Christensen often refers to certain philosophers or physicists of the French Enlightenment as either Cartesian or Newtonian (such as Mairan), while their actual orientations were less well defined.[28] For Christensen, perhaps, this is mostly because of the comprehensive nature of his book. In the context of explaining the whole of Rameau's theories and thoughtfully commenting on Rameau's philosophical influences, he cannot adequately examine the specific context of French Newtonianism and the nuances of its effects on Rameau's work, let alone the complicated meanings of "Newtonian" and "Cartesian" (though he does point out that the division between them is less clear than many historians have argued). My study provides a more detailed and specific discussion of the aspects of Rameau's theories that demonstrate the influence of Newtonianism as a cultural phenomenon, and situates Rameau and *Génération harmonique* in a precise historical context, that of the heated scientific debates in 1730s France.

Pinpointing the specific source of Rameau's knowledge of Newton is difficult. Rameau almost certainly did not read Newton's *Principia*, as it was generally regarded as too difficult for anyone but an expert mathematician and was originally published in Latin. Few of Newton's contemporaries, especially those in France, actually read *Principia*.[29] Rameau's *Génération harmonique* bears some resemblance to Newton's

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[27] Lester, *Compositional Theory in the Eighteenth Century*, 128.

[28] Christensen, *Rameau and Musical Thought in the Enlightenment*, 190.

[29] Shank, *The Newton Wars*, 49-50.

later work, *Opticks*, though it is unlikely that he read this work either; Rameau almost always cited scientists and philosophers whose work he read and admired, such as Descartes, Marin Mersenne (1588-1648), Sauveur, and Mairan. In other cases, however, it is possible that Rameau intentionally omitted citations when he had reason to do so. For example, Rameau stops citing Castel in *Génération harmonique*. Given Rameau's citations of other prestigious scientists, it seems likely that if he had read Newton, he would have cited him because of the potential prestige of this association. However, his lack of citations further indicates that he was influenced by a general, cultural Newtonianism without a single source.

I argue further that Rameau's use of certain characteristics associated with Newtonianism resulted in specific changes to his methodology for explaining and validating his harmonic theory, as presented in *Génération harmonique.* While Rameau initially sought validity for his theories through reason and mathematical truths, in *Génération harmonique* he also appealed to experimental science to prove the existence of certain musical phenomena.[30] This shift in approach resembles the style of presentations found within Newton's *Opticks*. *Génération harmonique* begins with a series of propositions and experiments, similar to those in Newton's *Opticks*, as well as other works of experimental science of the early eighteenth century. Rameau's experiments call for common household items, such as tweezers,[31] and are similar in this respect to Newton's, which sometimes call for a scrap of paper, a piece of coal, or a soap

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[30] Such an emphasis on experience instead of mathematical reason was also true of other Newtonian documents from this period. See especially Francesco Algarotti, *Le Newtonianisme pour les Dames*, 2 vols., trans. Duperron de Castera (Paris, 1738).

[31] Jean-Philippe Rameau, *Génération harmonique*, 17; Deborah Hayes, "Rameau's Theory of Harmonic Generation," 45.

bubble.[32] This mode of presentation recalls Newton's in its invitation to the reader to participate in experiments crafted by the author.[33] However, while such similarities seem to suggest familiarity with Newton's writing, they actually demonstrate a particular style of rhetoric frequently employed at the time. This format of hands-on experimentation and (public) demonstration was the subject of much discussion during the early eighteenth century. Mairan, for example, performed a demonstration of Newton's experiments from *Opticks* before the Academy in 1718, though he was fundamentally a Cartesian who argued against many of Newton's ideas.[34] Though Rameau certainly attempted to align himself with Newtonianism, he did this in a way that was common for many scientists of the time, not in a way that demonstrates an intimate knowledge and comprehension of Newton's work itself.

Rameau's experiments tie his work to Newtonianism more than any other aspect of *Génération harmonique*. The Dutch mathematician and Newtonian thinker Willem-James s'-Gravesande (1688-1742) wrote in 1721 that scientific work could be considered Newtonian even if only part of the work reflected Newtonian ideas.[35] He felt that his own work was Newtonian because some aspects of the work were associated with Newton,

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[32] Isaac Newton, *Opticks*, based on 4th edition (New York: Dover Publications, Inc., 1952), 20-1.

[33] Rameau, *Génération harmonique*, 17; Hayes, "Rameau's Theory of Harmonic Generation," 45.

[34] Shank, *The Newton Wars*, 153. See also Shank, *The Newton* Wars, 148, for a discussion of how experimental science became a "rhetorical vehicle" for defending Newton. See also: Abby Rose Kleinbaum, "Jean-Jacques Dortous de Mairan (1678-1771): A Study of an Enlightenment Scientist," Ph.D. diss. (Columbia University, 1970) for a detailed discussion of Mairan's philosophical orientation.

[35] I will refer to Desaguliers's English translation: William-James s'-Gravesande, *Mathematical Elements of Natural Philosophy Confirmed by Experiments, or An introduction to Sir Isaac Newton's Philosophy*, 2nd ed., 2 vols., trans. J. T. Desaguliers (London: J. Senex, Fleet-street, W. Innys and R. Manby in St. Paul's Church-yard, and T. Longman in Pater-Noster-Row, 1731). The original Latin title is *Physices elementa mathematica, experimentis confirmata, sive introduction ad philosophiam Newtonianam.*

such as the inductive use of empirical experiments.[36] On this basis, Rameau's experiments alone were enough to put him in the Newtonian camp. Even though he refers to similar experiments in *Nouveau système*, Rameau leads the reader through the experiments in *Génération harmonique* so as to emphasize the performative, observational aspect of empirical science. The experiments in *Génération harmonique* play a more significant role than in his earlier work.

In addition to Rameau's new use of experiments, he employs the concept of the "ear" to demonstrate the veracity of his theory, rather than abstract mathematical ratios. While he refers to listeners' experience in the two treatises that precede *Génération harmonique*, the ear takes on new significance in this treatise. In a sense, it can be understood as a signifier for musical experience in general. His new emphasis on experience further signals that he had a new faith in empiricism, the method most closely associated with Newton. In *Nouveau système*, Rameau says that the "testimony of the ear is always a confused sentiment without enlightenment."[37] This comment emphasizes reason over experience, reflecting a more Cartesian perspective. In *Génération harmonique*, however, Rameau suggests that the ear works together with our faculties of reason, and that the "judgment of the ear is always well-founded."[38] Rameau similarly

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[36] See Sarah Hutton, "Women, Science, and Newtonianism: Emilie du Châtelet versus Francesco Algarotti," 188, for more on s'-Gravesande's qualification for what made a document specifically "Newtonian."

[37] "Car l'Oreille dont le témoignage est toûjours un sentiment confus et sans lumiere." Jean-Philippe Rameau, *Nouveau système de musique théorique et pratique* (Paris: Ballard, 1726), 8; Glenn Chandler, "Rameau's *Nouveau système de musique theorique:* An Annotated Translation with Commentary," Ph. D. diss. (Indiana University, 1975), 194.

[38] "Le jugement de l'Oreille est toujours fondé." Rameau, *Génération harmonique*, 78; Hayes, "Rameau's Theory of Harmonic Generation," 103.

references the fundamental bass as "guiding" the ear, and the ear confirming what we know to be mathematically true about music. In such statements Rameau emphasizes the methodological importance of experience in *Génération harmonique*.

Rameau's theorization of the relationship between tonic, dominant, and subdominant also changed as the result of the influence of cultural Newtonianism. In *Génération harmonique*, Rameau explains these concepts with language that echoes descriptions of Newtonian gravitational attraction. In particular, Rameau invokes the concept of reciprocal relationship that Newtonians like Voltaire used to explain the gravitational attraction between the Sun, Earth, and the Moon.[39] Rameau's discussion of the *double emploi*, or the double employment of the chord with the added sixth, relates to this reciprocal relationship. Because Rameau prefers root motion by fifth in the fundamental bass, he adds a sixth to the subdominant (in C major: F-A-C-**D**). This added-sixth serves as the root (**D**-F-A-C) when the subdominant chord progresses to the dominant, while scale degree 4 (here, F) serves as the root when the chord progresses to the tonic. In both cases, root motion by fifth is maintained. Rameau states that the dominant and subdominant borrow dissonances from each other (scale degree 4 from the subdominant serves as the fundamental dissonance in the dominant chord, while scale degree 2 from the dominant serves as the added sixth in the subdominant). Both of these chords shares one scale degree with the tonic chord, and their "mutual lending" (*prêtent mutuelle*) binds them together.[40] In Rameau's explanation of their reciprocal relationship

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[39] Voltaire, *Lettres Écrits de Londres sur les Anglois et autres Sujets* (Paris, 1737), 69; Voltaire, *Lettres philosophiques*, ed. John Leigh, trans. Prudence Steiner (Indianapolis: Hackett Publishing Company, Inc., 2007), 54.

[40] Rameau, *Génération harmonique*, 112; Hayes, "Rameau's Theory of Harmonic Generation," 137.

we encounter language that is similar to Voltaire's description of the Sun as the gravitational center of the solar system, weighing on Earth and the other planets while they in turn weigh on it.[41] In both cases, the force of the Sun and the force of the tonic prompt motion. Just as gravitational attraction causes orderly motion among the planets, the reciprocal power among the three primary chords causes logical motion within a harmonic progression and the tonal system itself.

Though the evidence of Rameau's interest in Newtonianism is largely circumstantial, it is nevertheless true that his theories underwent changes in the 1730s that were characteristic of French Newtonianism. Speculating as to how Rameau was influenced by this movement leads us to a richer understanding of Newtonianism in the 1730s, especially its popularity. A consideration of the Newtonian aspects of Rameau's theories can cast light on the role Rameau played in the "Newton Wars." We may never have concrete evidence of his involvement with French Newtonians or his desire to imitate them, but examining his theory from this perspective is still revealing. By viewing his theory through a Newtonian lens, we can better understand how his theories were shaped in part by their historical and cultural circumstances, as well as the extent of the influence of French Newtonianism outside the purely scientific community.

From the letters, treatises, and other documents I discuss, it is evident that Rameau sought support from intellectuals inside and outside the Academy. Their approval would have elevated the status of his theory and, by extension, the whole of music theory as a discipline. Developing theories for composing and performing music

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[41] Voltaire, *Lettres Écrits de Londres sur les Anglois*, 69; Voltaire, *Lettres philosophiques*, trans. Prudence Steiner, 54.

was certainly important to Rameau, yet his unrelenting attempts to gain Academy membership in France, and to obtain official support from many of the most elite intellectuals of his day, point to another agenda. Gaining status for his theory would also enhance his own status as an intellectual. Rameau was not simply content with the success of his theories (or his compositions, for that matter); he insisted on being recognized as a philosophe. Such status would have granted not only substantial social benefits, but also potential financial benefits through Academy employment, including a government pension and perhaps even housing.[42] Prominent thinkers like Mairan enjoyed such benefits. Rameau may have seen membership in the Academy and public recognition as a scientist as a path to financial and social stability.

I divide my consideration of Rameau's attempt to create a scientific persona for himself into two parts: his efforts inside and outside the Academy. First, he attempted to gain support from inside the Academy through his connection to Mairan. He referenced Mairan throughout the first chapter of *Génération harmonique*, drawing on Mairan's experiments and theory of corpuscular sound. This "inside" approach ultimately had unintended results, as most reviewers associated these experiments with Mairan and Newton at a time when Newtonian physics was not fully accepted in the Academy. Next, I discuss Rameau's "outside" approach through his use of certain terminology that was popular among the growing group of educated elites outside the Academy. This

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[42] Shank writes that Mairan and other Academicians were sometimes given special housing at the Louvre as part of their compensation. See J. B. Shank, *The Newton Wars*, 101. Alice Stroup also writes of the pensions that many Academy members were paid, though payments were often delayed and many Academy members were paid too little to live solely off their pensions. Others were offered a small pension with room and board. Rameau would not likely have made enough money off such a pension to support his family, but in combination with the support of La Pouplinière and his position as a church organist, it is possible that an additional income would have greatly increased his overall earnings. Of course, this would have been in addition to the great social status that accompanied Academy membership. See Alice Stroup, *Royal Funding of the Parisian Académie Royale des Sciences during the 1690s*. 11-15.

Newtonian aspect of Rameau's language is not directly tied to one individual, but it bears the influence of Newtonianism as cultural phenomenon in general. Just as the first part of *Génération harmonique* focuses on experimental science, which was strongly connected with Newtonianism, the latter part deals with metaphors for tonal motion that are similar to Newtonian gravitational attraction. Readers may have associated Rameau's use of Newtonian rhetoric in *Génération harmonique* with popular Newtonian works like Voltaire's *Lettres philosophiques* (1734), and other texts that were aimed at educated non-experts. A comparison of Rameau's language with Voltaire's reveals their striking similarities. Through these inside versus outside approaches, we can see Rameau seeking general public approval by drawing on popular trends while also attempting to satisfy the Academy's expectations through a rigorous justification of his theories.

Literature Review

In order to situate Rameau in the context of the debates over Newtonianism, I will draw on primary sources by Rameau and his contemporaries and secondary scholarship on Rameau's theories. In order to provide adequate context for Rameau in eighteenth-century French culture, I will also draw on primary and secondary scholarship in eighteenth-century studies and French history.

Rameau's Treatises

I focus primarily on three of Rameau's treatises: *Traité de l'harmonie* (1722), *Nouveau système* (1726), and *Génération harmonique* (1737). I discuss *Génération*

harmonique in most detail. It is useful to think of these three treatises as mapping a progression in Rameau's thought. Rameau sought a scientific and mathematical foundation for his theories that he initially introduced in *Traité*. He then learned of the geometric progression and used it to theorize tonic, dominant, and subdominant relationships in *Nouveau système* and used experiments to prove the validity and existence of these relationships. The geometric progression served as a mathematical basis for harmonic relationships that he believed were already a part of musical practice. He also drew on recent acoustical theory in an attempt to substantiate his concept of the *corps sonore*. By the time of *Génération harmonique*, Rameau was influenced by Newtonianism and began to reshape his theory of modulation in language suggestive of Newton's theory of gravitational attraction. Each treatise thus marks a change in Rameau's presentation and justification of his theories through the inclusion of some new scientific or mathematical concepts that he encountered and adopted. In Chapter 5, I briefly discuss Rameau's two treatises from 1750 and 1752, *Démonstrations du principe de l'harmonie* and *Nouvelles réflexions de M. Rameau sur sa démonstration du principe de l'harmonie* to show how Rameau's theories underwent further change after the scandal surrounding Newtonianism had abated and Newton's work was accepted. The new discussion of these two treatises will help to illustrate that Rameau used Newtonianism strategically in the 1730s.

I will focus primarily on *Génération harmonique* because it displays the influence of cultural Newtonianism most strongly. Certain characteristics of this treatise indicate how it was shaped by cultural Newtonianism in the 1730s. It was

published in 1737, just three years after Voltaire's *Lettres philosophiques* (1734), the first French publication to disseminate Newton's notion of gravitational attraction.[43] Given that Newtonianism only began to cause public controversy in the 1730s, I believe it is unlikely that these Newtonian characteristics were part of Rameau's thought in *Nouveau système*. Neither of Rameau's earlier treatises (*Traité* or *Nouveau système*) shows the same influence of Newtonianism as a cultural phenomenon that is present in his later work. His use of experiments in *Nouveau système* is arguably non-Newtonian, as he merely mentions them without explaining them in detail.[44]

Nouveau système and *Génération harmonique* share some terminology. Rameau explains the relationship between the tonic, subdominant, and dominant in *Nouveau Système* with language similar to that used in *Génération harmonique*. It is also true that Newtonianism initially emerged earlier in the eighteenth century, before Rameau wrote *Génération harmonique*.[45] However, in *Nouveau système* Rameau theorized harmonic relationships, as well as many other concepts in terms of the geometric progression, a mathematical concept that he learned of through Castel.[46] It is important to remember when studying *Nouveau système* that the geometric progression is a series of ratios, associated with a rational, Cartesian

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[43] See Shank, *The Newton Wars*, Ch. 5, "Making the Philosophe," 295-342, for a detailed account of the debates and controversy that arose from Voltaire's publication of his *Lettres philosophiques*.

[44] Rameau, *Nouveau système*, iii; Chandler, "Rameau's *Nouveau système de Musique Theorique*,"160.

[45] Ibid., 46.

[46] Christensen, *Rameau and Musical Thought in the Enlightenment*, 178.

perspective. Furthermore, *Nouveau système* does not include the propositions and experiments of *Génération harmonique*, indicating that Rameau was not yet interested in promoting his theory through experimental science. French Newtonianism crystallized after Voltaire and Maupertuis began to write about it in the 1730s,[47] meaning that the cultural attitude toward Newtonianism changed during the time Rameau was writing *Génération harmonique*.

Rameau's later treatises retrospectively show the significance of his use of methods and language associated with Newtonianism in the 1730s. In *Démonstrations* (1750) and *Nouvelles réflexions* (1752), Rameau maintained very few of the Newtonian characteristics of *Génération harmonique*. Significantly, he no longer used Newtonian language to theorize the *double emploi* and the subdominant, indicating that he no longer needed his harmonic theory to resonate with Newtonian rhetoric. Through a comparison of these works with *Génération harmonique*, I will demonstrate that Rameau's use of Newtonianism in the 1730s reflects the particular cultural tensions of the decade in which it was written. The two treatises from the 1750s also represent the culmination of Rameau's efforts to be taken seriously as a scientist and to become a member of the Academy.

Enlightenment Figures

Rameau interacted with many figures in the intellectual elite whose works are relevant to my study. These include members of the Academy as well as other intellectuals he met

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[47] Shank, *The Newton Wars*, 295-304.

through his attempts to gain membership to the Academy and through his employment at the house of Alexandre le Riche de La Pouplinière (1693-1762). D'Alembert, for example, served as an advocate for Rameau in the scientific community. His writings about Rameau and their correspondence in the 1750s reveal how Rameau's theories were perceived by Academy members who wanted to support his musical endeavors without calling them scientific. From these documents we can see how the Academy's initial enthusiasm for Rameau's work declined after Rameau began to publish harsh critiques of the *Encyclopédie*. Among d'Alembert's greatest accomplishments was co-editing and contributing to the *Encyclopédie* until 1755.[48] Shank argues that by 1751 when the initial *Encyclopédie* articles were published, Newtonianism was completely accepted in France.[49] The *Encyclopédie* will allow me to refer to the general conception of Newtonianism as well as musical ideas among prominent intellectuals from the period after the Newtonian debates had subsided. As Rameau sought support from scientists and mathematicians outside of France, I will also refer to their letters to show how he solicited approval and scientific legitimacy for his theories. Letters to and from intellectuals such as Leonhard Euler (1707-1783) and Daniel Bernoulli (1700-1782) serve as examples of Rameau's attempts to gain broad recognition as a philosophe, and not just a musician.

In addition to d'Alembert, Rameau was also in contact with the well-known physicists and mathematicians Castel and Mairan, both of whom are usually described as Cartesians. Rameau's relationship to Castel is particularly significant because of Castel's

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[48] Denis Diderot, et al., *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, 17 vols. (Paris: 1751-65).

[49] Shank, *The Newton Wars*, 506.

combustive style of discourse. While the earlier custom in French intellectual debate had been to maintain courtesy, Castel was one of the first to engage in debates with outright hostility. As Shank writes,

> Castel rarely entered a discussion without enflaming it, and he therefore made the Jesuit journal a much more partisan and openly polemical voice on questions of philosophy and science than it ever was before.[50]

According to Shank, such hostility was one of the characteristics of the emerging French Newtonianism. Christensen has said that Castel introduced Rameau to the work of Cartesian physicist Ignace-Gaston Pardies.[51] Rameau quotes from Pardies's writing on colliding bodies in order to explain the significance of musical dissonance as the source of harmonic motion.[52] The writings of both Castel and Pardies reflect Rameau's initial philosophical perspective, which is often described as Cartesian.

The work of Mairan is also significant to the Newtonian aspects of Rameau's work. While Mairan maintained a Cartesian allegiance throughout his life, as stated above, the corpuscular concept of light in Newton's *Opticks* interested him, and provided a basis for his theory of sound corpuscles in his treatise "Discours sur la propagation du son dans les différens tons qui le modifient" (1737).[53] Rameau acknowledges Mairan in the *Génération harmonique*, and Mairan's ideas feature prominently in the experiments

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[50] Ibid., 163.

[51] Christensen, *Rameau and Musical Thought in the Enlightenment*, 108-111.

[52] Ignace-Gaston Pardies, *Oeuvres du R. P. Ignace-Gaston Pardies*, 2 vols. (Lyons, 1709), Book 2: *Un discours du mouvement local*. Cited in Jean-Philippe Rameau, *Traité de l'harmonie réduite à ses principes naturels* (Paris: J. B. C. Ballard, 1722), Supplement, 6-7; Philip Gossett, trans., *Treatise on Harmony* (New York: Dover, 1971), 79.

[53] Abby Rose Kleinbaum's dissertation is one of the only English-language secondary sources on Mairan. See: Abby Rose Kleinbaum, "Jean-Jacques Dortous de Mairan (1678-1771): A Study of an Enlightenment Scientist."

that begin the treatise.[54] Though Mairan's treatise was published just after the *Génération harmonique*, Rameau indicates that he and Mairan were in touch years earlier.[55] Mairan's writings give a sense of his own conflicting philosophical orientations and allow us to highlight similar conflicts in Rameau's writing. As Mairan is sometimes considered to be one of the sources of Rameau's knowledge of Newtonianism, his writings will aid in my discussion of Rameau's thought. In addition to Mairan's assistance with experimental science, Rameau may have also solicited his support in order to bolster his reputation within the Academy. His relationship with Mairan is one example of Rameau's many attempts at self-promotion through connections to prominent thinkers. As I discuss in Chapter 3, his reviewers did not hesitate to say that he capitalized on his relationship with Mairan in this way.

I discuss relevant aspects of Newton's *Opticks*, which allows for comparison to the later popularization of Newton's ideas by figures such as Voltaire. Newton's works enable me to demonstrate that Rameau did not take his understanding of ideas associated with Newtonianism from Newton himself. Voltaire's writings, however, are crucially important to my discussion of the influence of Newtonianism as a cultural phenomenon. I refer to Voltaire's *Lettres philosophiques* (1734), the French version of his *Philosophical Letters,* or *Letters Concerning the English Nation*, and his *Elémens de la philosophie de Newton* (1738), as well as his personal correspondence with French intellectuals. I draw on the critical introduction to *Lettres philosophiques* by Olivier Ferret and Antony McKenna in order to provide context for Voltaire's *Lettres* and the ensuing political

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[54] Rameau, *Génération harmonique*, 4.

[55] Ibid.

drama that followed their publication. Shank's treatment of the *Lettres* also factors into my discussion of Voltaire and his appropriation of subjects for his own political gain.

A comparison of *Génération harmonique* to other works of Newtonian science also highlights the Newtonian character of Rameau's work. I note the similarities and differences between Rameau's treatise and works by Étienne François Geoffroy (1672-1731), s'-Gravesande, Saulmon,[56] and Francesco Algarotti to show that *Génération harmonique* has much in common with these documents. Rameau's use of experiments aligns most closely with those of Newtonians outside the Academy who were still recognized as supporters of Newtonian science in their own time. Bernard le Bovier de Fontenelle (1657-1757), the Academy's Secretary, published responses to several of these works, criticizing their use of empirical observation. The work of these Newtonians and Fontenelle's reactions to them provides some context for the Academy's reception of Newtonian work and their hesitancy to accept Newtonian physics.

Secondary Scholarship on Rameau's Theories

Several authors have contributed valuable work on the technical aspects of Rameau's harmonic theory. Cynthia Verba, for example, has focused on Rameau's theory of modulation and situated it in relation to earlier French music theory.[57] She demonstrates that Rameau freely uses "modulation" in both the older and modern senses of the term, as

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[56] Saulmon was an eighteenth-century French scientist and mathematician. He does not seem to have published much and the extant publications appear with only his last name listed as the author. Shank notes that Saulmon entered the Academy with the low rank of an *élève* in 1707 (see Shank, *The Newton Wars*, 154). Other details of his life are unknown.

[57] Cynthia Verba, "Rameau's Views on Modulation and their Background in French Theory." *Journal of the American Musicological Society*, vol. 31, no. 3 (Autumn, 1978), 467-79.

both a progression within a key and a passing between keys. I will draw on her discussion of modulation as I situate this concept in terms of Newtonianism. Scott Burnham has written on Riemann's reception of Rameau, identifying his earlier thought as part of a mechanistic epistemology of the eighteenth century.[58] In *Compositional Theory in the Eighteenth Century*, Joel Lester provides a comparison between Rameau's theory and that of his contemporaries.[59] In addition to their translations of Rameau's treatises, the critical commentaries of Deborah Hayes,[60] Glenn Chandler,[61] and Roger Lee Briscoe[62] have greatly contributed to my understanding of Rameau's theory.

Thomas Christensen's work offers the most comprehensive treatment of Rameau's writings, especially in relation to Enlightenment thought.[63] He discusses Rameau's relationships with prominent intellectuals such as d'Alembert, Diderot, Mairan, and Rousseau. He carefully explains the changes to Rameau's musical thought over time and presents a broad picture of Rameau as a music theorist. However, the aim of Christensen's book is to provide a comprehensive account of Rameau's theory and the various philosophical trends that informed it, rather than a specific context for Rameau's

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[58] Scott Burnham, "Method and Motivation in Hugo Riemann's History of Harmonic Theory." *Music Theory Spectrum*, vol. 14, no. 1 (Spring, 1992), 1-14.

[59] Lester, *Compositional Theory in the Eighteenth Century*. See especially Chapter 4, "Rameau's Early Works," pp. 90-126, and Chapter 5, "Rameau's Later Works and Controversies," pp. 127-57.

[60] Hayes, "Rameau's Theory of Harmonic Generation."

[61] Chandler, "Rameau's *Nouveau système de musique théorique*."

[62] Roger Lee Briscoe, "Rameau's *Démonstration du principe de l'harmonie* and *Nouvelles réflexions de M. Rameau sur sa démonstration du principe de l'harmonie*."

[63] Before Christensen's text, the most comprehensive and significant single text on Rameau was Matthew Shirlaw's *The Theory of Harmony: An Inquiry into the Natural Principles of Harmony, with an Examination of the Chief Systems of Harmony from Rameau to the Present Day* (New York: H. W. Gray, 1917). Shirlaw positions Rameau within a grand narrative of the history of music theory.

relationship to Newtonianism. Christensen discusses the possible influence of Newton's theory of gravitational attraction and suggests individuals who may have exposed Rameau to Newton's work. However, he does not give us a sense of the complex and at times hostile dynamics of the Newtonian debates of the early eighteenth century.

Secondary Scholarship on the French Enlightenment and the History of Ideas

In order to gain a richer understanding of the intellectual climate of France in the early eighteenth century, I draw on the work of several Enlightenment historians and cultural theorists. James McClellan and François Regourd's *The Colonial Machine* provides some context for my discussion of the Academy by explaining its relationship to the French monarchy.[64] Their work focuses more on naval and civil engineering developments but they also identify a strong connection between the government and the Academy's achievements. Contributing to my understanding of similar academic organizations, Maurice Crosland's *Scientific Institutions and Practice in France and Britain, c. 1700-1870* compares the Academy to others in Britain and reveals the level of government involvement in the French system.[65] Alice Stroup's study of Academy finances in the 1690s gives an account of how various Academy members were paid and the hierarchical levels within the institution.[66] Though her study focuses on the Academy before its restructuring in 1699, much of her information on pensions is useful in discussing the

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[64] James E. McClellan III and François Regourd, *The Colonial Machine: French Science and Overseas Expansion in the Old Regime* (Turnhout, Belgium: Brepols, 2011), 72-84.

[65] Maurice Crosland, *Scientific Institutions and Practice in France and Britain, c. 1700-1870* (Burlington, VT: Ashgate/Variorum, 2007), 25-29.

[66] Alice Stroup, *Royal Funding of the Parisian Académie Royale des Sciences during the 1690s*, 11-15.

kinds of benefits Rameau might have gained from Academy membership. In a similar account of Academy membership, David J. Sturdy's discussion of the social and financial status attached to each level of Academy membership illustrates the social benefits Rameau could have received as a member.[67] The work of Albert Cohen and Leta Miller on music in the Royal Academy of London, as well as Cohen's study of music in the *Académie Royale des Sciences*, have greatly contributed to my understanding of the context of Rameau's relationship with the Academy.[68]

Scholarship on the changing journalist culture of the eighteenth century has also greatly aided my project. In *Contemporary Reactions to the Enlightenment (1728-1762)*, Cyril B. O'Keefe's chronicles the development of the *Journal de Trévoux* and other new French periodicals from the eighteenth century.[69] His treatment of the *Journal de Trévoux* provides background for my discussion of Rameau's polemic with Castel during Castel's tenure as editor of this journal.

The work of J. B. Shank has influenced my project enormously. His detailed and comprehensive discussion of the "Newton wars" suggests that the context for Rameau's *Génération harmonique* was a time of great cultural change and debate. Shank discusses many of the figures of the French Enlightenment with whom Rameau was in contact, such as Mairan and Castel. Rather than trying to establish a chronological narrative,

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[67] David J. Sturdy, *Science and Social Status: The Members of the Académie des Sciences, 1666-1750* (Woodbridge, England: The Boydell Press, 1995).

[68] Leta Miller and Albert Cohen, *Music in the Royal Society of London, 1660-1806* (Detroit: Information Coordinators, 1987); Albert Cohen, *Music in the French Royal Academy of Sciences.*

[69] O'Keefe, *Contemporary Reactions to the Enlightenment (1728-1762).*

Shank focuses on the larger cultural trends of the Enlightenment.[70] He also discusses Voltaire's use of Newton and Newtonianism as a way of creating his own public persona. Shank argues that this is the origin of the philosophe as an identity for French intellectuals who were not always associated with institutions. I draw on this idea to discuss Rameau's motivations for adopting scientific trends such as Newtonianism. Shank connects a variety of aspects of the period, such as journalism, the relationship between the Academy and the State, as well as broader issues of European politics, thus creating a rich backdrop against which to study Rameau's works.

It is worth noting that, in addition to many positive reviews, Shank's work has received one particularly scathing review from Mordechai Feingold. In his critique of Shank's approach (which includes the work of Foucault and the concept of historical geneology), we can see Feingold's general dislike of "postmodern" studies of history. He writes, "One is left to ponder the effects of fashionable trends on sound scholarship."[71] He also criticizes the mathematical details of Shank's explanations of certain issues, including the Leibniz-Clarke dispute over calculus. Such details are not relevant to my project, and my intent is not to draw on every aspect of *The Newton Wars*. I am less concerned with the details of eighteenth-century mathematics than with the responses to Newtonian works that dealt with mathematics and science. Cultural and individual responses to Newtonian texts and the Academy's and the public's attitudes toward

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[70] In Patricia Fara's review of Shank's *Newton Wars*, she notes that despite Shank's efforts to move away from a chronological retelling of the Enlightenment, he still relies on dates and does construct a sort of timeline centered around the first half of the eighteenth century. See Patricia Fara, "Review of J. B. Shank, *The Newton Wars and the Beginning of the French Enlightenment*," *The Journal of Modern History* vol. 82, no. 1 (March, 2010): 200-201.

[71] Mordechai Feingold, "Review of *The Newton Wars and the Beginning of the French Enlightenment*, by J. B. Shank, *Isis* 101 (2010): 186.

Newtonianism are easily discernable in Shank's study. Feingold asserts further that Shank's errors imply a general weakness in the rest of the work. Based on my own study of primary sources from which Shank also draws, I do not agree. Neither, for that matter, do his other reviewers (discussed below) who have commended his research.

Feingold accuses Shank of only citing the beginnings of primary sources (prefaces). Based on my own research with many of the same primary source materials, I do not find that to be true. I have studied many of the primary sources that Shank cites in order to compare Rameau's work with Newtonian works of the time. I find that these sources support Shank's arguments and that he draws from them holistically. When he does cite prefaces, this is often because the author used that section to lay out his central arguments. I do not find Feingold's review to be particularly even-handed.

Shank's idea of "self-fashioning" lies at the center of much of Feingold's criticism. He writes, "To debate whether the imprecise notion of 'self-fashioning' is a useful historical device is beyond the scope of this [review]."[72] I would argue, however, that studying the historical figures of the early French Enlightenment from the perspective of "self-fashioning," the development of their public personas as scientists and thinkers, helps us to understand their motivations. We can grasp what they stood to gain from fashioning themselves in this way, and how new relationships emerged between the State, the public, and the individual during this time. Understanding their texts as cultural products caught up in this process of self-fashioning reveals the historical situated-ness of their ideas. For these reasons, I believe that studying "self-fashioning" as a historical device adds much to our appreciation of the French Enlightenment.

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[72] Ibid., 181.

In discussing these aspects of his review of *The Newton Wars*, I do not mean to debate Feingold, only to dispute his criticisms. The more detailed historical inaccuracies he points out are important and seem like issues that an editor should have caught before publication.[73] I do mean to defend Shank's broader arguments, which the other reviewers unanimously found to be sound and impressive. I find this book to be an invaluable resource and critical account of the primary sources of this period. Specifically, I believe that Shank provides a thoughtful account of Voltaire's activities and his relationship to the culture at large. For these reasons, I cite and refer to Shank's work frequently, and I believe it is worthy of serving this prominent role in my project.

Indeed, Shank's other reviewers responded far more positively. Patricia Fara writes that Shank's approach is laudable and that *The Newton Wars* will remain the definitive work on Newton for years to come.[74] Christopher Baxfield writes that overall, Shank's book is "well researched and readable," and that it is a considerable improvement over similar work by Jonathan Israel.[75] Virgil Nemoianu describes Shank as a "first-class scholar," though he questions the utility of Shank's excessive detail.[76] However, for my project, Shank's meticulous use of primary sources has been a crucial resource for locating and reading many obscure documents on Newtonian science.

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[73] Virgil Nemoianu mentions minor errors in dates and spelling and believes that they are not Shank's fault. "Review of *The Newton Wars and the Beginning of the French Enlightenment* by J. B. Shank," *The Review of Metaphysics*, vol. 62, no. 3 (March, 2009), 694.

[74] Fara, "Review of *The Newton Wars and the Beginning of the French Enlightenment*," 200.

[75] Christopher Baxfield, "Review of *The Newton Wars and the Beginning of the French Enlightenment* (Chicago: University of Chicago Press, 2008)," *The British Journal for the History of Science*, vol. 42, no. 2 (June, 2009), 304.

[76] Nemoianu, "Review of *The Newton Wars and the Beginning of the French Enlightenment* by J. B. Shank," 693-94.

Neither Shank nor Feingold has any interest in situating Rameau within the intellectual debates of the time. Shank's work reveals the epistemological conflicts endemic to Enlightenment science that also pervade Rameau's work. For this reason, his text has been crucial to my project.

Secondary Scholarship Connecting Rameau with Enlightenment Thought

As part of his work on Rameau and Enlightenment thought, Christensen suggests similarities between Rameau's revised harmonic theory and Newtonian physics. However, his examples of Rameau's interest in Newtonian science are not sufficient evidence of a real influence of Newton's works on Rameau's thought.[77] Christensen cautions his readers from carrying the analogy of Newtonian science too far when reading Rameau, yet he strongly suggests such a connection himself.[78] For instance, he claims that Rameau patterned *Génération harmonique* after *Opticks*,[79] even though many other texts from that period shared the same structure of propositions and experiments. He also claims that Mairan was a likely source of Rameau's knowledge of Newtonianism[80] but does not sufficiently explain that Mairan's philosophical orientation was, at best, a complex combination of Newtonian and Cartesian values. As I will discuss

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[77] Raphaëlle Legrand similarly lists Newton's *Opticks* among the scientific works that influenced Rameau's later harmonic theory. Her text serves as a less detailed overview of Rameau's theoretical ideas. She also cites Christensen and refers to *Opticks* without providing substantial evidence that Rameau was familiar with the text. See Raphaëlle Legrand, *Rameau et le Pouvoir de l'Harmonie*, 34-35

[78] Christensen, *Rameau and Musical Thought in the Enlightenment*, 190.

[79] Ibid., 188.

[80] Ibid.

in Chapter 3, the "Newtonianism" in Mairan's experiments is complicated by his membership in the Academy and his fidelity to Descartes, the latter perhaps a function of Fontenelle's adamant resistance to anything in the Academy that opposed Cartesianism. In addition, Mairan's influence is most evident in the experiments at the beginning of *Génération harmonique*; yet Christensen's main example of the gravity-like quality of the tonic comes from a later chapter on dissonance and the *double emploi*. Christensen does acknowledge a difference between Newton and Newtonianism[81] but tends to use the terms interchangeably, not fully distinguishing them.

In order to press the Newton-Rameau connection further, Christensen compares a passage about the tonic, subdominant, and dominant from *Génération harmonique* to a passage from *The Newtonian System of Philosophy*, a Newtonian text aimed at young, non-experts.[82] Christensen finds Rameau's language to be similar enough to the Newtonian text to demonstrate the influence of Newtonian science.[83] However, the passage that Christensen describes as Newtonian from *Génération harmonique* contains similar language to that used in *Nouveau système*, such as a "desire" (*desirer*) for the tonic, or the dominant or subdominant "returning to its source" (*retournant à sa source*).[84] As *Nouveau système* was published in 1726, before French Newtonianism developed, these examples do not indicate a real Newtonian influence. Further, Christensen suggests that Rameau would have learned of Newtonian science while

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[81] Ibid., 146.

[82] *The Newtonian System of Philosophy; Explained by Familiar Objects, in an Entertaining Manner for the use of Young Ladies and Gentlemen by Tom Telescope*, revised edition (London, 1798).

[83] Christensen, *Rameau and Musical Thought in the Enlightenment*, 189.

[84] Rameau, *Nouveau système*, 30; Chandler, "Rameau's *Nouveau système de musique theorique*, 249.

working with Voltaire at the house of La Pouplinière, but his relationship with Voltaire did not begin until 1731, after Rameau had already drafted language in *Nouveau système* that Christensen describes as Newtonian.[85] Other aspects of *Génération harmonique* are substantially different from those of *Nouveau système* and indicate that Rameau was, in fact, influenced by Newtonianism. However, Christensen's examples from *Génération harmonique* are nearly identical to those in the earlier treatise. While the connections that Christensen suggests between Rameau and Newton are not fully developed, his work has been invaluable to my own as it has led me to examine Rameau's works in the context of the tension surrounding French Newtonianism.

Though Christensen carefully measures his claims about Rameau and Newton, his reviewers are less careful. In a review of Christensen's text, Albert Cohen lists Newtonian gravity among a slew of Enlightenment influences on Rameau.[86] Cynthia Verba's review of the same book states that Rameau's works were regarded as models of Newtonian science in their own time.[87] Based on the contemporary reactions to Rameau's use of science and mathematics, including d'Alembert's complete removal of any mathematical material from the *Élémens de Musique*, I find this claim implausible. As I discuss in Chapter 3, eighteenth-century reviewers of *Génération harmonique* immediately made the connection between Rameau's experimental methodology and Newton's *Opticks*, and easily tied it to the work of Mairan. However, their comparisons

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[85] Christensen, *Rameau and Musical Thought in the Enlightenment*," 187-190.

[86] Albert Cohen, "Review of *Rameau and Musical Thought in the Enlightenment*, by Thomas Christensen," *Music and Letters*, vol. 76, no. 1 (1995) 99.

[87] Cynthia Verba, "Review of *Rameau and Musical Thought in the Enlightenment*, by Thomas Christensen," *The Journal of Modern History*, vol. 67, no. 2 (June, 1995), 436.

were not particularly favorable. Certain reviewers questioned Rameau's need for mathematics and science in his theories, as well as his competence with these tools. Further, Christensen does not claim that Rameau's works were regarded as models of Newtonian science in their own time. He gives examples of how Rameau was compared with Newton, and instances when his accomplishments were considered as important to music as Newton's were to optics.[88] These comparisons, however, are meant as praise for Rameau's theoretical work, not as arguments that Rameau's work was itself Newtonian. Christensen is correct to say that Rameau's work was regarded as scientific; though his contemporaries sometimes doubted his ability to carry out the scientific aspects of his work, they recognized his attempts to present music theory scientifically through the tools of mathematics, geometry, and physics. Certainly Rameau's desire to make his work appear scientific is evident.

Reviewers of Christensen's book tend to be far less nuanced in their statements about Rameau's theory than Christensen. This is, of course, a function of the brief format of a review. Still, their comments demonstrate that Christensen's nuance is in some way lost in their reading of the text. Walter E. Rex, a Diderot scholar, bases his understanding of Rameau's work on Christensen's text, and states that Rameau's later theory involved the tonic as a center of musical "attraction," even though Rameau never uses this term.[89] Christensen does refer to the "attractive" quality of the tonic, though he does not claim

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[88] Christensen, *Rameau and Musical Thought in the Enlightenment*, 7-10.

[89] Walter E. Rex, "Review of *Rameau and Musical Thought in the Enlightenment* by Thomas Christensen," *Diderot Studies*, vol. 27 (1998), 249. Rex also politely suggests that Christensen's text is too densely technical for a non-musician to understand, but he does find much of Christensen's work useful and thoughtfully done.

that Rameau *believed* in a kind of musical gravity.[90] Given the controversy in France over the term "attraction" and its importance to Newtonianism, it is likely that Rameau would have used "attraction" had he wanted to draw such an explicit connection between Newton and himself. Patricia Howard similarly writes that, "Rameau's objective was nothing less than to create a new science of music theory comparable with the 'new physics' of Newton, and as accessible to the lay enquirer. Ironically, his starting point was Cartesian…" I would argue that this was not, in fact, Rameau's objective. His knowledge of Newtonianism and the influence of Newtonian physics on his work remain difficult to clearly establish. Further, Christensen himself never claims that this was Rameau's goal. Yet Christensen's reviewers imply this connection as though it was the main point of Rameau's (and Christensen's) argument. Granted, the short length of these reviews inhibits the authors from treating each detail of the reviewed work. However, these reviewers make claims that Christensen was careful not to overextend.

By contrast, Brian Hyer discusses the influence of cultural Newtonianism on Rameau as related in Christensen's book. He explains in Foucauldian terms how Rameau figures as the "founder of a discursive practice." According to Hyer, it was possible for Rameau to have been influenced by Newtonianism whether or not he had personal knowledge of Newtonian physics:

> It is hard, moreover, to imagine that Rameau ever read a word of Newton, or much Descartes for that matter. Yet he would not have had to: Rameau would not have needed direct knowledge of Newton in order to devise a gravitational account of the mode.[91]

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[90] Christensen, *Rameau and Musical Thought in the Enlightenment*, 190.

[91] Brian Hyer, "Before Rameau and After: Review of *Rameau and Musical Thought in the Enlightenment*, by Thomas Christensen," *Music Analysis*, vol. 15, no. 1 (March, 1996), 82. Verba also writes that Christensen's book raises an important question as to the relationship between Rameau as an individual and

In other words, Rameau did not need to be aware of Newtonianism to be entangled in it. In addition, Hyer suggests that Rameau was likely less aware of the Newtonian aspects of his writings than his readers were.[92] By this logic, Rameau's work was Newtonian because his readers identified the connections between his theories and Newton's, not because he self-consciously referred to Newton in his works. This is evident in reviews of *Génération harmonique* by Castel and others, and, according to Hyer, in the reactions of Castel and d'Alembert. Hyer cites Castel as reacting negatively to Rameau's adoption of certain Newtonian characteristics (an issue I discuss in Chapter 4) and d'Alembert as having been more supportive of Rameau as he moved toward a gravitational theory of harmony. To return to Shank's idea of "self-fashioning," Rameau's aspiration to elevate his work to the level of science resulted in his work being associated with Newtonianism.

Hyer identifies one of the greatest strengths in Christensen's project: his ability to identify rather than attempt to resolve the epistemological contradictions in Rameau's theories. In my study of Rameau I hope also to "proliferate and intensify," as Hyer says, the tensions in and surrounding Rameau's work.

Methodology

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the larger Enlightenment culture. She rightly points out that dialectical process at work between the theorist and the culture makes it difficult for scholars like Christensen to identify the source of individual ideas. This aspect of her review signals the potential futility in searching for a single source of Rameau's Newtonianism. See Cynthia Verba, "Review of *Rameau and Musical Thought in the Enlightenment*, by Thomas Christensen," 436.

[92] Ibid., 83.

Through a discussion of the primary sources outlined above, I develop the claim that Rameau was influenced not by Newton, but by Newtonianism as a cultural phenomenon in France. These sources provide a rich context for Rameau's work that shows how it reflects the intellectual and cultural tensions of its day. Just as Shank has argued that Newtonian physics (and the eventual acceptance of Newtonianism) was not inevitable, I argue that Rameau's theories of the fundamental bass, the subdominant, and the *double emploi* (and their quasi-scientific explanations) were not inevitable music-theoretical developments. Rameau's use of scientific language to theorize these concepts shows that they were dependent on some imperative in procedure – real or imagined – perceived by the theorist.

In order to define Newtonianism and explain its cultural significance in France, I draw on secondary literature such as Shank's *The Newton Wars*, as well as Henry Guerlac's *Newton on the Continent*,[93] his *Essays and Papers in the History of Modern Science*, and other literature in the history of science and the French Enlightenment.[94] I also include close readings of many primary sources, especially Voltaire's *Lettres philosophiques* and the writings of other eighteenth-century scientists and philosophers. Newton's *Opticks* will enter the discussion, as it was central to the dissemination of his ideas in France, due to its popular style of presentation.[95] The writings of other prominent French thinkers, such as Castel and Mairan, will help to create a historical context in

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[93] Henry Guerlac, *Newton on the Continent* (Ithaca: Cornell University Press, 1981).

[94] Henry Guerlac, *Essays and Papers in the History of Modern Science* (Baltimore: Johns Hopkins University Press, 1977).

[95] Shank, *The Newton Wars*, 113.

which Rameau wrote the *Génération harmonique*. I draw on Shank's argument that Voltaire used Newton to create an enlightened persona for himself in order to discuss Rameau's use of Newtonianism to make his work appear scientific, and to discuss the consequences of his cultivating a scientific reputation.

Given that Newtonianism was particularly significant to Rameau's theories in the 1730s, I focus on the *Génération harmonique* (1737), while also referring to his earlier treatises, *Traité* and *Nouveau système*. In my final chapter I refer to Rameau's writings following *Génération harmonique*, including *Démonstrations du principe de l'harmonie* (1750) and *Nouvelles Réflexions* (1752), in order to show the aftermath of Rameau's involvement in the Newtonian disputes of the 1730s. To establish a connection between Newtonianism and Rameau, I trace Rameau's conceptions of modulation, the fundamental bass, the subdominant, and the *double emploi* through these treatises in order to demonstrate how the language he used to theorize these concepts changed as a result of the influence of Newtonianism. In particular, I demonstrate how Rameau's concept of "mutual lending"[96] between the tonic, dominant, and subdominant evokes the same reciprocal power (*la puissance réciproque*)[97] that Voltaire discusses in connection with the planets. Voltaire's description of the force that makes the planets and the sun "weigh"[98] on each other is similar to Rameau's descriptions of the tonal force that connects the tonic, dominant, and subdominant. I also discuss experimental science as an

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[96] Rameau, *Génération harmonique*, 112; Hayes, "Rameau's Theory of Harmonic Generation," 137.

[97] Ibid., 163; Hayes, 190.

[98] Voltaire, *Lettres Écrits de Londres sur les Anglois*, 69; Voltaire, *Lettres philosophiques*, trans. Prudence Steiner, 54. Voltaire's use of the word *pesateur* is often translated as "weight," from the verb *peser* (to weigh), as in, one body "weighs on" another.

aspect of Newtonianism in a broader sense, and Rameau's use of experiments and his concept of the "ear" in *Génération harmonique* as manifestations of that Newtonian influence.

Studying the role of Newtonianism in Rameau's theory of harmony from the 1730s provides a more specific context for Rameau's theories than the current scholarly literature offers. I study Rameau as a figure enmeshed in the cultural values of his time, and I view his writings as reflecting contemporary epistemological values. This approach to the history of music theory represents an attempt to account for its complicated and often contradictory nature. I seek to clarify but also complicate our understanding of Rameau. Treated in this way, Rameau appears not as a heroic figure of music history, but as an individual with a shifting interest in particular epistemological and, ultimately, political values endemic to eighteenth-century France.

Brief Chapter Summaries

In this first chapter I have outlined the topic, reviewed relevant literature, and explained my methodology.

Chapter Two involves a detailed discussion of primary sources from Rameau's contemporaries, focusing especially on the writings of Voltaire, Newton, Mairan, and Maupertuis. Their writings help create a historical context for each of Rameau's treatises that I discuss. They also further define French Newtonianism and its major components in the early eighteenth century. Understanding the differences between these authors as well as their relationships with Rameau allows me to illustrate the intellectual milieu of Rameau and French scientific thought.

In Chapter Three, I discuss the Newtonian aspects of *Génération harmonique* as manifested in Rameau's use of experiments. As his experiments were based on those of Mairan, I also discuss Mairan further, and Rameau's possible attempts to exploit their relationship for his own professional gain. I explain the aspects of Rameau's experiments that are similar to those of Newton's *Opticks* as well as those that differentiate Rameau's approach from that of experimental science. Following this, I compare Rameau's use of experiments to other contemporary documents that are considered Newtonian in some sense. These documents further define French Newtonianism and its relationship to experimental science, and they help us to understand Rameau's use of both. Through a study of these primary sources I demonstrate the ways in which Rameau's work can specifically be called "Newtonian" and the implications of his having adopted Newtonian characteristics for his theory.

In Chapter Four I examine Rameau's Newtonianism as manifested in his conceptualization of the *double emploi* and the discursive similarities between this section of *Génération harmonique* and Voltaire's explanation of gravitational attraction in *Lettres philosophiques*. This chapter provides a topical reading of three of Rameau's treatises: *Traité* (1722), *Nouveau système* (1726), and *Génération harmonique* (1737). I trace Rameau's conception of modulation and the fundamental bass as his interest in Newtonianism developed. In the course of my analysis of Rameau's concepts of the fundamental bass and modulation, I also discuss the subdominant, the role of dissonance in the *double emploi*, and the question of harmonic motion driven by tonal attraction to the tonic, versus dissonances with movement analogous to colliding bodies. My discussion of these topics provides specific evidence of the influence of Newtonianism on

Rameau's writings and the related tension between Newtonianism and Cartesianism still present in his musical thought. I also discuss Castel's reaction to the Newtonianism in *Génération harmonique* and the polemic that ensued between Castel and Rameau. Voltaire ultimately came to Rameau's defense, invoking Newton in his explanation of Castel's shortcomings. From this polemic and Voltaire's response we can see that Rameau became entangled in the Newtonian debates, as Voltaire associated him more strongly with his own brand of Newtonianism.

Chapter 5 summarizes and provides some final observations on Rameau's use of Newtonian methods and language. I discuss the aftermath of the Newtonian debates in the scientific and intellectual community to show how the cultural tension around French Newtonianism subsided by mid-century as Newtonian physics gained broad acceptance across Europe. Then I discuss Rameau's *Démonstration* (1750) and *Réflexions* (1752) to show that, while Rameau continued to include certain ideas or terms associated with Newtonianism in his later work, Newtonianism no longer played a significant role in his work. I discuss Rameau's letters to Bernoulli and Euler, two prominent scientists who he hoped would approve of his work. Ultimately I argue that Rameau used ideas associated with Newtonianism in the 1730s when it was most controversial and popular, and that these later documents show that Rameau removed this content from his later writing in order to seek scientific recognition by other means, throwing his previous use of Newtonianism into relief. Finally, I consider broader applications of my research methodology and plans for future research in the history of French music theory. A similar method of studying primary source material in light of scientific and philosophical trends could be usefully applied to the work of many of the figures

discussed here, such as d'Alembert and Voltaire, as well as other aspects of Rameau's theory, and music in the French Enlightenment.

Chapter 2: Rameau's Contemporaries

In this chapter, I will discuss how Rameau's contemporaries in France portrayed Newton and Newtonianism in their writings as well as Rameau's relationship to each of these authors. Discussing their work serves to complicate our understanding of French Newtonianism as a complex and at times self-contradictory cultural movement. Rameau did not have a close relationship with many of the individuals discussed here. However, understanding their work and the intellectual climate around Newtonianism shows us how the stage was set for Rameau to enter the discussion through his *Génération harmonique*.

In order to create this backdrop for reading Rameau's work, I focus on five issues and themes in the rise of French Newtonianism. First, I discuss the work of Voltaire and the idea of accessible science written for non-expert readers, as well as the use of scientific work to enhance one's public reputation. As Voltaire was one of the earliest advocates for Newton in France in the 1730s, the same decade in which Rameau wrote *Génération harmonique*, his writings and correspondence feature prominently in this chapter. By examining the work of academician and mathematician Pierre Louis Maupertuis (1698-1759), I explain the significance of the growing interest in Newtonianism inside the *Académie Royale des Sciences* (hereafter the Academy) and compare it with Voltaire's work outside the Academy. Together, the work of these two authors galvanized support for Newton among a faction of French intellectuals and the public and created the French Newtonianism movement. The writings of Bernard le Bovier de Fontenelle (1657-1757) illustrate institutional reactions to Newtonianism among the older generation of Academy members. From Sarah Hutton's study of works

of "soft" Newtonianism, we can see that Rameau and other writers used new scientific ideas and methods associated with Newtonianism to make their texts more accessible to non-experts. Finally, I discuss Newtonianism in the articles of the *Encyclopédie* of Denis Diderot (1713-1784) and Jean le Rond d'Alembert (1717-1783). Studying the way the authors of the *Encyclopédie* treated Newtonianism shows how Newtonian physics and philosophy had gained general acceptance by the 1750s when the initial articles were published.

These five issues surrounding the rise of French Newtonianism illustrate the complexity of the period in which Rameau published *Génération harmonique* and provide a context for the issues that I raise in Chapters 3 through 5. In this chapter I draw on secondary scholarship on the early French Enlightenment in order to situate each of my five authors; however, the focus is primarily on primary sources. Understanding the work and context of the authors discussed in this chapter will clarify Rameau's strategic use and then dismissal of ideas and methods that were associated with Newtonianism.

Voltaire's *Lettres philosophiques*

Voltaire, born François-Marie Arouet (1694-1778), became familiar with Newton's work while in exile in England in 1726. Known for his sarcastic, sensationalist tone and frequent polemical statements, Voltaire's exile was partly the result of public statements that offended church leaders.[1] It is no coincidence, then, that Voltaire framed the

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[1] Voltaire, *Lettres philosophiques,* edited by Olivier Ferret and Antony McKenna, Introduction (Paris: Classiques Garnier, 2010), 10. These included, for example, his statements that the Old Testament was a collection of old fables, that the apostles were gullible idiots.

Newtonianism in his later *Lettres philosophiques*[2] in a manner that would be palatable to Jesuits and other church leaders, to ensure his security with the church establishment.[3] After his return to France in 1729, Voltaire and Rameau formed an artistic relationship. The two collaborated on operas during the time when Voltaire was writing his *Lettres* and Rameau was writing *Génération harmonique*. I discuss their collaborations and their relationship at length in Chapter 4, but it is worth stating here that their relationship began just as Voltaire began to advocate for Newtonian physics and philosophy in France.

During his stay in England, Voltaire tried to position himself among elite intellectuals and to cultivate relationships with prominent English thinkers. As a result of these relationships and his own study of English philosophy and science, Voltaire developed a new enthusiasm for English culture. When his exile ended in 1727, he elected to stay in England for a short period just after the death of George I. His successor's wife, the new Queen, Caroline of Ansbach, enthusiastically supported the arts and humanities, and Voltaire chose to stay to take advantage of new opportunities.[4] In 1728, he began writing the essays that make up *Lettres philosophiques* as a way of reflecting on his work in England, his meetings with prominent English thinkers, and his general experiences with English culture.

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[2] In this chapter I will not discuss Voltaire's *Éléments de la philosophie de Newton* or *Dictionnaire philosophique*. These texts were written after Rameau had published *Génération harmonique* and they are therefore less pertinent to this study.

[3] Jonathan Israel, *Enlightenment Contested* (Oxford: Oxford University Press, 2006), 756-57.

[4] Voltaire, *Lettres philosophiques,* edited by Olivier Ferret and Antony McKenna, Introduction, 11.

It is important to note that some difficulty in studying this text arises from its different versions. The English version, published first in 1733, included slightly different content than the French version published in 1734, which included an additional essay on Blaise Pascal (1623-1662), whom Voltaire admired. Since their original publications, the French version has been translated into English numerous times, but these modern English translations of *Lettres philosophiques* are not the same as the original *Letters Concerning the English Nation.* The quotes provided here are my own English translations of the original French text.

The four essays discussed here make up letters thirteen through sixteen of twenty-five in total, and Voltaire creates a connection from one to the next. First he introduces John Locke and English philosophy; he then introduces Newton by comparing him to Descartes, followed by an explanation of Newton's concept of gravitational attraction and finally his *Opticks*. These four letters convey Voltaire's new brand of Newtonianism most effectively. Though Voltaire's *Lettres* were written after some of the other documents discussed here, they are perhaps the strongest and most enthusiastic public defense of Newton, and so I discuss Voltaire's construction of Newtonianism first.

Voltaire sets the stage for his promotion of Newtonianism by first discussing English philosophy and the empirical work of John Locke. In his essay on Locke, we see Voltaire's initial use of a rhetorical technique common in *Lettres philosophiques*: Voltaire discusses another author's work in terms of himself and uses another's work to portray himself in a certain way. For example, Voltaire refers to Locke's claim that he would wait for someone "smarter" than he was to come along and determine whether the soul existed before the body, or whether the soul was material like the body. Voltaire

believes that this statement points to Locke's modesty as a philosopher, and says that he, too, would like to be "stupid" like Locke. He portrays Locke as philosophically modest and then says he would like to be considered the same way.[5] After outlining Locke's ideas and their occasionally controversial implications, Voltaire presents his own interpretation, positioning himself as the mediator who could present Locke's ideas in a digestible manner for non-expert readers.

Through his descriptions of Locke, Voltaire portrays the empirical, observational method as one of general modesty. According to Voltaire, Locke was not a great mathematician; he did not seek to define everything we know, but he sought to examine what it is we want to know.[6] Voltaire describes Locke's method as if he were observing a child from birth in order to study its progress and cognitive development. Locke embodies the detached, neutral observer, who never presumes to know things *a priori*, just as the child surveys its surroundings without inherently knowing them. For Voltaire, Locke's philosophical modesty in his observational method constituted a rejection of Descartes's *cogito ergo sum*. Voltaire states, "I am a body, and I think: I do not know any more than that."[7] To Voltaire, existence did not depend on thought.

Counterbalancing Locke's modesty, in Voltaire's eyes, was a willingness to "dare" to propose controversial ideas, to question, and to speak positively.[8] As Voltaire says, Locke dared to propose or even suggest something radical while maintaining his

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[5] Voltaire, *Lettres philosophiques,* 110.

[6] Ibid.,108-9.

[7] "Je suis corps, et je pense: je n'en sais pas davantage." Voltaire, *Lettres philosophiques,* 111. All translations in this chapter are my own**.**

[8] Ibid., 109.

modesty. Voltaire imitates this by saying courteously, "If I dared to speak in the manner of M. Locke on such a delicate subject, I would say…"[9] He then explains his idea that men have debated the nature of the soul forever, and that it is impossible to demonstrate its immortality or materiality. Voltaire speaks on behalf of Locke here: if Locke were to debate the corporeality of the soul with the scholastics, he would have modestly asked them to admit that they were as ignorant as he was. And he would then ask how *they* would dare to assert that they know what the soul is made of or that they understood the relationship between body and spirit. In this imaginary debate, Voltaire portrays Locke as humble, yet courageous enough to stand up to those who assert their claims with hubris. Voltaire-as-Locke says to these imagined scholastics:

> At least confess that you are as ignorant as me. Neither your imagination nor mine could conceive how a body can have ideas; and do you understand moreover how a substance, such as it is, has ideas? You do not imagine either matter or spirit. How can you claim that you actually know anything?[10]

In the process of speaking on Locke's behalf, Voltaire is able to portray Locke a certain way and to portray himself accordingly. He imagines statements that he would like for Locke to have said while further establishing himself as a philosophical authority.

Voltaire frequently imagines such conversations between these deceased authors and their opposition. He also speaks on behalf of Newton in his defense of Newtonian ideas. In this way, Voltaire allows (or forces) Newton or Locke to respond to current criticisms but from his own perspective. Perhaps Locke would have said otherwise, but it

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[9] "Si j'osais parler après M. Locke sur un sujet si délicat, je dirais…" Ibid., 111.

[10] "Confessez du moins que vous êtes aussi ignorants que moi; votre imagination ni la mienne ne peuvent concevoir comment un corps a des idées; et comprenez-vous mieux comment une substance, telle qu'elle soit, a des idées? Vous ne concevez ni la matière ni l'esprit; comment osez-vous assurer quelque chose?" Ibid., 112.

is useful for Voltaire to imagine that he would have made these specific claims. It helps him flesh out a sympathetic, likeable persona for Locke while imposing this persona onto Locke and onto himself. Throughout *Lettres philosophiques*, Voltaire staged debates between his subjects and their detractors in order to let the imagined philosophical arguments play out. In each case, his subjects are unable to participate in a real debate because they have long since died. Their fictional personas serve to affirm Voltaire's perspective and lend authority to his own arguments.

In summary, Voltaire's treatment of Locke is an example of his process of portraying each subject, and himself in relation to that subject, throughout *Lettres philosophiques*. He provides an example of someone like Locke making a statement, then imagines something that Locke *could have said*, and finally argues similarly himself. This rhetorical technique appears frequently in his letters on Newton and Descartes and has some relevance to the rise of French Newtonianism. By portraying Locke, Newton, and Descartes in this way, Voltaire humanizes them and their work for a reading public that might otherwise not have encountered them. Voltaire removes the jargon and dense circumlocutions from their work and presents them in personal terms. When Voltaire speaks on behalf of these authors, he then capitalizes on his own humanist portrayal and adopts the same qualities that he has bestowed on these authors for himself. In this way, he introduces the most accessible version of each author and then adds to his own authority to comment on philosophical issues.

In the case of Locke, Voltaire aims to prove that Locke was not opposed to religion, but that a Lockean, modest and yet courageous approach to philosophy would enhance religion:

> For what philosophy is more religious than that which, merely affirming what it conceives clearly and able to proclaim its weakness, tells you from the outset that it requires recourse to God upon examining first principles?[11]

In other words, Voltaire argued that Lockean philosophy allowed for a concept of God that did not threaten traditional religion. Voltaire's interpretation of Lockean religious tolerance further illustrates his search for acceptance of his ideas among Jesuits and the church. He frames his discussion of Locke in a way that would appeal to French religious leaders: "Moreover, one must never fear that not a single philosophical sentiment can erase the religion of a country."[12] Voltaire may not have truly believed that philosophy was harmless in this way. He was likely aware of how such freethinking posed a threat to the church. However, he surely knew that portraying English philosophy as harmless to the church would have assuaged some of the church's fears about new philosophical and scientific developments.

Voltaire then turns from Locke to Newton and portrays Newton's ideas in a way that similarly benefits himself. In the fourteenth letter, Voltaire begins his discussion of Newton by comparing him with Descartes. This letter serves to prepare his French readers who would have resisted his assertion that Newton and his system should replace that of Descartes. However, rather than coldly dismissing Descartes and the French intellectual establishment, he portrays Descartes as a man who suffered misfortune, whose daughter died in childhood, and who was rejected by French scholars. Voltaire's Descartes was dealt an unfortunate lot in life, one made worse by his French colleagues,

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[11] "Car, quelle philosophie plus religieuse que celle qui, n'affirmant que ce qu'elle conçoit clairement et sachant avouer sa faiblesse, vous dit qu'il faut recourir à Dieu dès qu'on examine les premiers principes?" Voltaire, *Lettres philosophiques,* 113.

[12] "D'ailleurs, il ne faut jamais craindre qu'aucun sentiment philosophique puisse nuire à la religion d'un pays." Ibid., 113.

who, according to Voltaire, cheated him out of his position in French society.[13] Perhaps Descartes could have accomplished more, Voltaire implies, had his life been easier.

Voltaire then begins his portrayal of Newton as the prototypical philosopher, praising the English for appreciating Newton properly during his lifetime. Voltaire's Newton was happy, professionally recognized, and honoured by his countrymen.[14] Newton's happiness was in large part the result of his having been born in a free country, Voltaire says, continuing his depiction of England as more liberal, tolerant, and forward thinking than France.[15] Per Voltaire, the English treated Newton like a hero, as though he were the fabled Hercules: "We have here the Hercules from the myth to whom the uninformed attributed all the feats of other heroes."[16] This is not to say that Newton's greatness was due to the public crediting him with the accomplishments of others. Rather, this statement emphasizes the magnitude of Newton's reputation in his own time. In reality, Newton probably led a much less happy life. He was known to be at least somewhat mentally disturbed and, during what may have been a suicidal period in his youth, he threatened to burn down his parents' house with them inside.[17] As Voltaire notes, Newton never married, a fact he used to paint Newton as lacking weakness, with a passion only for science. Yet no matter how much Voltaire praises Newton, he is initially

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[13] Ibid., 115-116.

[14] Ibid., 116-117.

[15] Ibid., 116. Earlier, in his eighth letter, on English parliament, Voltaire compares the English to the Romans in their political and societal advancement; see Voltaire, *Lettres philosophiques*, 89-91.

[16] "Il est ici l'Hercule de la fable, à qui les ignorants attribuaient tous les faits des autres héros." Ibid., 117.

[17] The Newton Project, Professor Rob Ilife, director: http://www.newtonproject.sussex.ac.uk/prism.php?id=15, accessed 18 August, 2014.

careful not to criticize Descartes too harshly: "One can admire Newton [with respect to his sensual restraint], but one need not fault Descartes."[18]

Thus far, Voltaire begins his discussion of Newtonianism with a portrayal of the modest but courageous empiricism of Locke (and implicitly English philosophy) and proceeds to a polite rejection of Descartes. Voltaire argues that Descartes did what he could and that it was time for Newton to carry his work forward. Ultimately, Voltaire says, it is unfair to compare Descartes and Newton: "The first is an essay, the second is a masterwork."[19] His gentle rejection of Descartes is meant to prepare the French reader for the following explanation and defense of Newton's system of attraction. It is important to note that, while Voltaire softened his criticisms of Descartes, Newton cannot truly be seen as "carrying forward" the work of Descartes. Rather, Newton's work rendered Cartesian physics impotent. However, Voltaire likely saw the need to portray Descartes in a positive light in order draw on the loyalties of his French readership.

In the fifteenth letter, "Sur le système de l'attraction," ("On the System of Attraction") Voltaire contributes to Newtonian mythology by relating the story of Newton conceiving of gravity while watching fruit fall from a tree. Here, as in the previous letter, Voltaire speaks as Newton, describing the falling fruit and how it immediately led him to theorize the inverse-square law.[20] Voltaire-as-Newton asks himself:

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[18] "On peut admirer en cela Newton, mais il ne faut pas blâmer Descartes." Voltaire, *Lettres philosophiques*, 117.

[19] "La première est un essai, la seconde est un chef-d'oeuvre." Ibid., 118.

[20] This can be summarized as: the force of attraction between bodies is inversely proportional to the square of the distance between those bodies.

> Why would this power not extend itself to the Moon? And if it is true that [this force] penetrates as far as that, is it not very likely that this power holds it [the Moon] in its orbit and determines its movement?[21]

In Voltaire's depiction of this scene, Newton quickly connects the falling fruit to the gravitational relationships between the planets, conveying Newton's brilliance but perpetuating the rather mundane story of how Newton arrived at his ideas.

Voltaire immediately identifies Newton as philosophically modest, thus associating him with Locke in the previous letter. For example, he explains that Newton's initial calculations of planetary attraction were not compatible with the known measurements of Earth. Given these problems of calculation, Voltaire writes, Newton decided to abandon the project. Only after the French scientist Jean-Félix Picard correctly calculated the circumference of Earth was Newton able to proceed with his calculations that demonstrated attraction between the planets and the Sun. Picard did this, in Voltaire's words, "to the glory of France," and Newton's system of attraction depended on it entirely. Thus, while Newton's system "destroyed" the Cartesian system of vortices, Voltaire was able to show that it succeeded because of the work of a Frenchman.[22]

While Voltaire praises Locke, he deifies Newton. According to Voltaire, Newton's calculations of gravitational relationships elevated human knowledge past a

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[21] "Pourquoi ce pouvoir ne s'étendrait-il pas jusqu'à la Lune? Et, s'il est vrai qu'il pénètre jusque-là, n'y a-t-il pas grande apparence que ce pouvoir la retient dans son orbite et détermine son mouvement?" Voltaire, *Lettres philosophiques*, 121.

[22] Voltaire, *Lettres philosophiques*, 122. In his later *Éléments de la philosophie de Newton*, Voltaire says that Newton actually received the correct measurements from an English scientist named Norwood. See Voltaire, *The Elements of Sir Isaac Newton's Philosophy. By Mr. Voltaire. Translated from the French. Revised and Corrected by John Hanna, M. A. Teacher of the Mathematicks. With Explanation of some Words in Alphabetical Order.* (London: Printed for Stephen Austen at the Angel and Bible in St. Paul's Church-Yard, 1738), 201.

point thought possible.[23] Voltaire speaks as Newton in order to let the latter defend himself against the charge that gravity was an occult force.[24] Speaking as Newton, Voltaire defends his use of the word "attraction," rather than "impulsion" as his French colleagues suggested.[25] Voltaire-as-Newton explains that scientists do not understand impulsion any better than they do attraction, and that "impulse" implied a force pushing on each object (such as Descartes's vortices), rather than a gravitational pull. (It is worth noting that both attraction and impulsion are forces, which would make them equally occult with respect to eighteenth-century science.) Voltaire-as-Newton summarizes his system of gravitational attraction: he has proven that the planets exert force on each other and the Sun, that gravity is the force that controls their movement, that another cause of universal motion would be impossible, that objects fall in proportion to their weight, and that the planets move in the same proportion. He argues that all planetary motion is demonstrable because of his calculations.[26]

After defending Newton's ideas, Voltaire provides his own defense for gravity: he does not believe it to be occult, but its cause is unknown because gravity is heavenly. In this passage, Voltaire transforms gravity from an occult force to a Christian mystery whose cause cannot and should not be known. To drive home this point, he quotes the Book of Job (incorrectly) to say that mankind was allowed to pursue knowledge to this

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[23] Ibid., 123.

[24] For more on Newton's actual interest in the occult, see *Newton and Newtonianism: New Studies*. James Force and Sarah Hutton, eds. (New York: Kluwer Academic Publishers, 2004), passim.

[25] Voltaire, *Lettres philosophiques*, 125.

[26] Voltaire, *Lettres philosophiques*, 126-7.

point but no further.[27] Again Voltaire seeks the support of religious leaders by portraying Newton's system as somehow more holy and more compatible with Christian teachings than any alternative.

The sixteenth letter, "Sur l'Optique de M. Newton" ("On Newton's Opticks"), contains a basic explanation of Newton's *Opticks,* including his work with light, prisms, and the color spectrum. Up to this point, Voltaire's letters already displayed an important characteristic of cultural Newtonianism by explaining Newton's system of attraction without using dense mathematical language or examples. This was typical of texts aimed at the general public, who had begun to develop an appetite for work like Newton's when written in accessible language. Newton's *Opticks* itself was characterized this way, in contrast to his earlier treatise, *Principia Mathematica* (1687). Voltaire's letter on Newton's *Opticks* has another feature in common with Newtonian works aimed at the broader public: it suggests a hands-on activity for readers to try at home. *Opticks* had many such activities, as did other characteristically Newtonian documents aimed at the educated non-expert, including Rameau's *Génération harmonique*. Voltaire suggests that the reader find a fresh piece of yellow wood, and with the use of the prism shine various rays of colourful light onto the branch. As each ray shines on the branch, the wood takes on the corresponding color, proving that the color of the light is a part of the light itself, not a characteristic of the object on which it shines.[28]

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[27] Ibid. 127. In Prudence L. Steiner's English translation, the editor notes in endnote 9, p. 141, that Voltaire misquotes Job, 38:11. Voltaire writes "*Procedes huc, et non ibis amplius.*" It should read "*Usque huc venies, et non procedes amplius.*"

[28] Ibid., 129.

Even though this letter focuses on Newton's *Opticks*, Voltaire continues to compare Newton and Descartes. He asks, how would Descartes have reacted had he seen Newton prove wrong his theories about light? How would he respond if one could go back in time and tell Descartes that a man would come who could dissect light "with more dexterity than the most skilled artist would dissect a human body?"[29] Voltaire announces Newton's arrival as though he were royalty: "This man has arrived! Newton, using only the prism, has demonstrated to the naked eye that light is a mass of colourful rays, which together, yield the color white."[30] His announcement is directed not just toward the imagined Descartes, but also his followers and perhaps all French readers who might have maintained loyalty to Descartes. As before, however, Voltaire is careful not to condemn Descartes for misunderstanding light. Voltaire excuses Descartes's incorrect understanding of light because of his other contributions to human knowledge. Throughout his discussion of Newton in each of his *lettres*, Voltaire refers to Descartes as one who deserves respect, but whose time as the most important philosopher in France has passed.

Voltaire returned to France from exile in 1729 and worked to rebuild his finances until the end of that year.[31] As others have noted, the government's harsh reaction to *Lettres philosophiques* probably resulted from Voltaire's tone (at times brash and sarcastic), his attitude toward religious institutions, and the circumstances of its publication, and not from the content (though the content was likely at least somewhat

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[29] "…avec plus de dextérité que le plus habile artiste ne dissèque le corps humain," Ibid., 129.

[30] "Cet homme est venu! Newton, avec le seul secours du prisme, a démontré aux yeux que la lumière est un amas de rayons colorés qui, tous ensemble, donnent la couleur blanche." Ibid., 129.

[31] Voltaire, *Lettres philosophiques,* edited by Olivier Ferret and Antony McKenna, Introduction, 14.

offensive). [32] Voltaire published the English version of the text, *Philosophical Letters, or Letters Concerning the English Nation* in August 1733, and assumed that it would not cause a scandal in England. He tried to halt its publication in France as he did not have permission to publish the book in its entirety, particularly because of the letter on Locke. However, his publisher, Jore, opted to publish it in 1734 without Voltaire's permission. According to J. B. Shank, the Royal Seal drafted a *lettre de cachet* (a direct order from the King) that would have sent Voltaire to the Bastille; however, the letter never reached Voltaire, who had already fled to Cirey with his mistress, the philosopher and mathematician, Émilie du Châtalet.[33] Jore was sent to the Bastille in June 1734 and copies of the French version of *Lettres philosophiques* were publically shredded and burned by the hangman. Shank and others have pointed out that the premature publication of the *Lettres* was unintended on Voltaire's part and that he had hoped the book would not be as controversial as it turned out to be.[34] As Jonathan Israel has said, the manner in which the book was published was the source of the government's outrage, rather than the offensive content and tone of the book itself[35]

The response from French intellectuals was less dramatic. Before the French version was printed, the Abbé Prévost (1697-1763) wrote a lengthy review of all the letters based on the English version. Regarding the essays on Newton, Prévost said that Voltaire's attempt to pose as a philosophe was dry and boring, as he simply presented and

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[32] Ibid., 18. See also, J. B. Shank, *The Newton Wars* (Chicago: University of Chicago Press, 2008), 303.

[33] Shank, *The Newton Wars*, 302-303. See also: Voltaire, *Lettres philosophiques,* edited by Olivier Ferret and Antony McKenna, Introduction, 18-19.

[34] Shank, *The Newton Wars*, 303.

[35] Jonathan Israel, *Enlightenment Contested*, 755.

commented on Descartes's and Newton's systems, rather than saying anything interesting about them. Prévost preferred Fontenelle's somewhat older style of discourse to Voltaire's.[36] While his French contemporaries did not object to Voltaire's Newtonianism outright, they criticized his style of argument and questioned his intentions.

Maupertuis

At the same time that Voltaire began to create a public persona for himself as a French Newtonian, Maupertuis took a softer approach in gathering support for Newton's ideas inside the Academy. With a less provocative writing style than Voltaire's, Maupertuis crafted his Newtonian writings to preserve and further his position within the Academy. His success in growing support for Newtonianism among Academy members illustrates the difference between Maupertuis's work as an academician and Voltaire's "outside" approach to gaining status and authority. Though Rameau and Maupertuis were evidently unaware of each other's work, Maupertuis's advocacy of Newton in the Academy makes him relevant to this discussion.

Maupertuis was born to a well-connected family that enabled him to rise through the Academy's ranks in a traditional way.[37] In addition to institutional support, his academic status gave his Newtonianism more credibility than Voltaire's among intellectuals outside the Academy, at least initially. It is important not to characterize Voltaire as representing the whole of Newtonianism outside the Academy, while

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[36] Shank, *The Newton Wars*, 337. Shank quotes from: Steve Larkin, ed. *Le pour et contre. Nos. 1-60* (Oxford: Voltaire Foundation, 1993).

[37] Shank, *The Newton Wars*, 236.

Maupertuis represents only the inside perspective. As Shank points out, most Academy members were concerned with their public images by the early eighteenth century, seeking both academic and public approbation, and rendering the outside-inside academic distinction less entrenched. Still, we can refer to Maupertuis's work as "inside" the Academy in that he presented it to Academy members, discussed it at Academy meetings, and published it with their approval. [38]

Maupertuis is commonly regarded as the first Newtonian inside the French Academy, and he cultivated a following of young Academy members who were also interested in Newtonianism.[39] In addition to his *Discours sur les différentes figures des astres* (1732), he presented two shorter explanations of gravitational attraction at Academy meetings. His work on the shape of Earth and other Newtonian ideas became popular with these younger Academy members.[40] Newtonianism, for those who agreed with Maupertuis, became an alternative philosophical stance, different from that of Fontenelle and other older members.[41] Correspondence between Voltaire and Maupertuis from this period indicates that Voltaire encouraged Maupertuis to advocate for Newtonianism inside the Academy, perhaps hoping that their endorsement would

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[38] Maupertuis was also a member of the Royal Academy in London where he initially presented his Newtonian work. Shank suggests he presented his work there first in order to avoid aligning himself too closely with Newtonianism in France. Shank, *The Newton Wars*, 237.

[39] Shank discusses Maupertuis's presentations of Newtonian science in the Academy (see *The Newton Wars*, 322-23). He also cites d'Alembert as having written in his *Preliminary Discourse* that Maupertuis introduced the French to Newtonian science. See Shank, *The Newton Wars*, 17; d'Alembert, *Preliminary Discourse to the Encyclopedia of Diderot*, Richard N. Schwab, trans. 2nd ed. (Chicago: University of Chicago Press, 1995), 89.

[40] Shank, *The Newton Wars*, 323. Shank cites: Maupertuis, "Un eclaircissement sur les principes de M. Newton," *Procès verbaux de l'Académie royale des sciences*, December 23, 1732, and ""Sur la loi générale de l'attraction Newtonienne," *Procès verbaux de l'Académie royale des sciences*, January 21, 1733.

[41] Ibid., 324.

encourage the broader intellectual community to accept Newtonianism.[42] As Shank points out, the distinction between scientific writing aimed at academic and public readership became less clear, and Voltaire was prepared to take advantage of the new public interest in science. But that public interest also bolstered Maupertuis's public reputation outside the Academy.[43]

Maupertuis published his *Discours* about eighteen months before Voltaire published the French version of *Lettres philosophiques*. Though Maupertuis obtained the Academy's approval, he did not publish it through the Academy, nor did he present his work to them before publishing it, as he considered it too polemical for their meetings.[44] An overview of the chapters reveals that the document was meant to be a particular kind of presentation and defense of Newton's ideas, especially in the context of the increasing tension surrounding Newton in the 1730s. Maupertuis begins with an explanation of Earth's shape, using Newton's ideas in part to defend his own.[45] According to Shank, the very idea of discussing the shape of the planet indicated that this was a Newtonian text, as its shape, whether round or slightly elongated, was an issue closely associated with Newton's work.[46]

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[42] Ibid., 322.

[43] Ibid., 240.

[44] Ibid., 238.

[45] Pierre-Louis Maupertuis, *Discours sur les différentes figures des astres avec une exposition des systèmes de MM. Descartes et Newton*, (Paris, 1732), 5-9.

[46] Shank, *The Newton Wars*, 324.

While Shank claims that Maupertuis did not defend Newton as much as provide material for someone else to defend him,[47] I believe his *Discours* contains several examples of just such a defensive stance. He justifies his and Newton's use of the word "attraction," rather than impulsion, just as Voltaire does, and justifies Newton's use of observation.[48] Then he defends Newton's lack of explanation for the cause of gravity, again, just as Voltaire does.[49] In Chapters 3 and 4, he lays out Descartes's system of motion, discussing first the theory of colliding bodies that transfer energy through their collisions.[50] He also explains in detail Descartes's theory of vortices (*tourbillons*), including his idea of planetary bodies "swimming" in fluid.[51] In each case, Maupertuis lays out Descartes's ideas and then carefully argues against them using geometry and his own calculations. Finally, he presents Newton's solutions to each of these problems and the Newtonian system of planetary motion through gravitational attraction.[52]

Though Maupertuis and Voltaire both attempted to promote Newtonianism in France, their works differ in several ways. The tone of Maupertuis's discussion is significantly more moderate and less dramatic than that of Voltaire's *Lettres*. Further, Maupertuis's interpretation of Descartes is genuinely more sympathetic than Voltaire's. While Voltaire humanizes Descartes by discussing details of his personal life, Maupertuis

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[47] Ibid., 238.

[48] Maupertuis, *Discours sur les différentes figures des astres*, 11-12.

[49] Ibid., 13.

[50] Ibid., 11.

[51] Ibid., 22-29.

[52] Ibid., 34ff.

attempts to evaluate Descartes on the basis of his work. He finds Descartes's ideas to be beautiful and admirable, if problematic.[53] Maupertuis tries to maintain a certain neutrality in explaining and then defending Newton's work; however, this apparent neutrality renders his defense of Newton that much more apparent. His argument is not personal or polemical as is Voltaire's; yet he demonstrates that with a measured, impartial approach to the systems of the two scientists, Newton's emerges as superior.

Maupertuis's *Discours* is said to have influenced Voltaire and motivated him to publish on Newton.[54] Voltaire was likely attracted to Maupertuis's rhetoric, particularly the moment in which he speaks for the philosophes. He imagines their response to his discussion of whether attraction or impulsion is the better word for the force Newton describes: "But, will one say, perhaps, that bodies do not have an impulsive force?"[55] While Maupertuis uses this rhetorical device sparingly, Voltaire, as we have seen, employs it frequently in his defense of Newton and Locke. Comparing Voltaire and Maupertuis further, Shank points out that while Voltaire explained Newtonianism in terms of empiricism and physics (Newton observing fruit falling and then theorizing its fall, for example), Maupertuis explains Newton's ideas in terms of mathematics.[56] This is especially true of the final chapters of *Discours* in which Maupertuis presents problems in Cartesian and Newtonian reasoning and then calculates various solutions.[57] He

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[53] Ibid., 33.

[54] Shank, *The Newton Wars*, 239.

[55] "Mais, dira-t-on peut-être, les corps n'ont point la force impulsive?" Ibid., 17.

[56] Shank, *The Newton Wars*, 319.

[57] Maupertuis, *Discours sur les différentes figures des astres*, 50ff.

emphasizes Newton's use of geometry to express planetary motion and attraction, rather than Newton's use of empiricism, though he defended it earlier on.[58] Unlike Voltaire's later text, aimed at the educated, non-expert, Maupertuis's academic account of Newtonian physics was meant for other academicians to read.

While the earlier sections of the text clearly favour Newtonian science, Maupertuis acknowledges at the end of his discussion that impulsion may be a more valid concept than attraction. He states that attraction and impulsion are equally possible, and that the same methods can be used to prove the existence of both concepts. He is unsure whether attraction truly is an internal quality of matter, and he claims that he cannot prove that impulsion is a false concept. But, if he had to choose, he would choose the simpler, Newtonian, system.[59] Earlier in the text he claimed that to reconcile Cartesian physics with the current understanding of planetary motion would be too complex. But he emphasizes at the end of the chapter that it may be possible to serve both systems so that that neither Descartes nor Newton should dominate the other. This is particularly weak language, given his intention to compare Newton and Descartes and to demonstrate the validity of Newtonian physics with mathematical proof. Maupertuis presents Descartes's ideas and proves them to be false or at least problematic and illogical. He then presents Newton's ideas and claims they are better because they are more mathematically viable than those of Descartes. But in his final comments he claims to be unsure of which system is ultimately true. This last comment demonstrates Maupertuis's efforts to remain at least somewhat neutral and to stay in the good graces of the senior

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[58] Ibid., 36.

[59] Ibid., 45.

members of the Academy such as Fontenelle and other publically prominent thinkers like Castel.

Castel

Father Louis-Bertrand Castel (1688-1757), a Jesuit and avid supporter of Descartes, also responded to the new enthusiasm for Newtonianism in France through his critiques of Newton and his followers. It is worth noting that before Newtonianism became popular in France, Rameau and Castel enjoyed an amiable professional relationship. Castel helped Rameau develop a theory of musical dissonance based on the Cartesian theory of colliding bodies of Ignace-Gaston Pardies.[60] Their relationship soured, however, after Rameau took an interest in experimental science. I will discuss their dispute over *Génération harmonique* in Chapter 4. However, it is worth discussing Castel's critiques of Maupertuis in order to understand Castel's position with regard to Newtonianism and empiricism in general.

In Castel's 1733 review of Maupertuis's *Discours*, he harshly criticizes Maupertuis and Newton. Castel outlines the content of Maupertuis's chapters and criticizes them one by one, especially Maupertuis's idea that the Earth's shape was spheroid. Castel attacks Maupertuis's indecisive treatment of attraction versus impulsion, in which he suggests both are viable ideas. Here, Castel argues that the force in question

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[60] Christensen, *Rameau and Musical Thought in the Enlightenment*, 109.

might as well be called "repulsion." Perhaps, he suggests, the sky is repulsed by the Earth, and objects fall toward the Earth because they are pushed.[61]

In reading Castel's review, one senses that Castel felt that Newtonians like Maupertuis criticized "Cartesians" for believing in ideas that had already been dismissed decades earlier. Maupertuis claims that the Cartesian explanation of *pesanteur*, or the planets "dragging" (exerting force on) each other, is inadequate. Castel responds that of course the Cartesian explanation is inadequate, as most Cartesians would agree. Castel implies that Maupertuis only tries to give the impression that he is presenting new ideas, rather than actually stating something new.[62] When Maupertuis finds a single failing in the Cartesian system, Castel argues, he casts off the entire system as insufficient; because of the imperfections of *pesanteur*, Maupertuis regards the whole system as incapable of revealing any truths.[63]

Castel criticizes Maupertuis and Newton alike for their overreliance on calculations to explain their ideas, in keeping with Newton's penchant for the use of mathematics to explain physical concepts. Castel complains that Maupertuis relies totally on mathematics and geometry. The problem with mathematical arguments, says Castel, is that they are hypothetical. Maupertuis claims to have established various Newtonian concepts through calculation, but Castel says that his mathematical facts are just hypotheses. Further, by this logic, Castel argues that the Cartesian concepts that

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[61] Louis-Bertrand Castel, "[Review of] Maupertuis, *Discours sur les différentes figures des astres*," *Journal de Trévoux,* April, 1733: 707-708.

[62] Ibid., 709.

[63] Ibid., 710.

Maupertuis judges as hypothetical are just as valid as his own Newtonian "facts."[64] He adds that Maupertuis obsesses over his calculations in the final chapters of *Discours*, and that his ideas would benefit from a little less calculus and a little more discussion.[65] Finally, Castel claims that even Newton did not fully support his own philosophy, enveloped as it was in his dense geometry, and that it cannot be considered sound.[66]

Ultimately, Castel strongly disagrees with Maupertuis's reasoning and his criticisms of Descartes. He implies that Maupertuis followed Newton blindly, and he finds many of Newton's ideas similarly suspect. In some ways, Maupertuis was out-maneuvered by Castel, who argues more fervently, and was likely in a better position as editor of *Journal de Trévoux* to engage in such a debate**.** As a representative of elite intellectual society at the time, his criticism can be seen as a public response to Newtonianism from someone who was not a member of the Academy.

Fontenelle

In 1727, when Newton died, the Academy secretary, Fontenelle, wrote an *Éloge*, or eulogy, as he typically did for Academy members and other prominent intellectuals. In order to prepare the *Éloge*, Fontenelle contacted John Conduitt, the husband of Newton's niece, who knew Newton's work and life well. Fontenelle acknowledges Conduitt in his *Éloge* and credits Conduitt with having looked after Newton's affairs near the end of his

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[64] Ibid., 710-711.

[65] Ibid., 713.

[66] Ibid., 716.

life.[67] Their correspondence indicates that Conduitt was the source of Fontenelle's knowledge of Newton's life and work.[68] Like Maupertuis, Fontenelle did not interact with Rameau. However, his role in the gradual acceptance of Newton in France makes him significant to this discussion. From Fontenelle's reactions to Newtonian works we can also see the Academy's response to Newtonian physics. This response is especially relevant to my discussion in Chapter 3 of Rameau's "inside" approach to gaining status within the Academy.

Newton in Fontenelle's *Éloge* is more than the greatest scientist and philosopher of the age – he is a deity. Fontenelle quotes from a poem by Lucain[69] describing how the Ancients were not permitted to know the source of the Nile: "Men have not been permitted to see the Nile weak and nascent [that is, at its source],"[70] implying that Newton discovered truths that Nature had previously hidden from mankind. So beloved was Newton by the English that he saw his own apotheosis before his death: "Finally he was revered to the point that his death could no longer produce new honours for him, he had seen his own apotheosis."[71] According to Fontenelle, Newton had privileged access

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[67] Bernard le Bovier de Fontenelle, "Éloge de M. Neuton," in *Histoire de l'Académie Royale* (Paris, 1729), 169.

[68] Fontenelle to Conduitt, April 14, 1727. The Newton Project, Rob Iliffe, director. http://www.newtonproject.sussex.ac.uk/view/texts/normalized/THEM00149. Accessed 28 August, 2013.

[69] Fontenelle spells the poet's name as Lucain, which differs from the conventional spelling, Lucan.

[70] "Qu'il n'a pas été permis aux hommes de voir le Nil foible et naissant." Fontenelle, "Éloge de M. Neuton,"152.

[71] "Enfin il a été reveré au point que la mort ne pouvoit plus lui produire de nouveaux honneurs, il a vû son Apothéose." Ibid., 166.

to Nature and was capable of reducing her mysteries to calculations.[72] He compares Newton to God creating fire (or here, calculus), which was stolen by Prometheus (or, as Fontenelle says, Leibnitz) and given to mankind.[73]

Fontenelle also emphasizes Newton's modesty, just as Voltaire and Maupertuis did in their later documents. He tells a story of Newton waiting to publish some ideas because Mercator, his colleague, had discovered them first. Fontenelle says of Newton, "But he was content with his own wealth and did not seek glory."[74] Fontenelle's Newton enjoyed financial success, but did not work to obtain social status. He claims that Newton self-consciously strove for modesty. Newton in this portrait displays a sort of admirable stoicism. When in pain near the end of his life, Fontenelle reports, he did not cry out, but simply endured it.[75] In a way, this language is expected in a eulogy, with the deceased often portrayed as saintly and his or her accomplishments exaggerated. In this case, however, Fontenelle portrays Newton as a figure whose accomplishments far exceed those of his contemporaries. Fontenelle wrote many *Éloges* for the Academy memoires and few contain language like this one. Other *Éloges* for scholars of lesser stature are also shorter. While Fontenelle emphasizes their good characteristics and highlights their important contributions to science or philosophy, he does not present them as gods.[76]

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[72] Ibid., 162.

[73] Ibid., 154.

[74] "Mais il se contenta de la richesse, et en se picqua point de la gloire." Ibid.,153.

[75] Ibid., 169.

[76] See Fontenelle's other *éloges* in *Éloges des Académiciens de l'Académie Royale des Sciences, Morts depuis l'an 1699* (Paris, 1766).

After outlining the details of Newton's life, Fontenelle explains Newton's system of gravitational attraction. Though his presentation of Newton's ideas is mostly positive, his tone in describing the reciprocal relationship of the planets and the Sun indicates that he does not quite believe Newton's findings to be true. If the Moon weighs on Earth with the same force that Earth weighs on it and if the same force is at work among all the heavenly bodies, meaning that all of Nature is one, then the whole universe is controlled in the same way. He indicates that it would be nice if this was the case, but he cannot know for sure.[77]

Like other authors writing on Newtonianism, Fontenelle compares Newton and Descartes. He says that the two philosophers were often pitted against each other, but he first points out their similarities. Both were considered geniuses of the first order who dominated others of their time and founded philosophical and scientific canons. Both were excellent geometers who recognized the necessity to combine geometry with physics. However, Descartes was interested in finding first principles in order to understand Nature, taking a deductive, top-down approach. Newton was more modest; he started with observable phenomena whose cause was unknown, taking an inductive, bottom-up approach. But, says Fontenelle, each one was only inhibited by the limited capacity for knowledge of the human spirit, not by their individual, limited understanding.[78] Fontenelle describes Newton's ability to enjoy his own success during his lifetime, as well as Descartes's misfortune. His reasoning resembles Voltaire's, as he says that the English did not hesitate to praise their own geniuses. Like Voltaire, he faults

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[77] Fontenelle, "Éloge de M. Neuton,"156-7.

[78] Ibid., 160.

the French for not properly recognizing Descartes while he was alive. Fontenelle describes Tacitus reproaching the Romans for their extreme indifference toward the great men of their empire, while the English did the opposite.[79]

Fontenelle also discusses Newton's silence on the cause of gravity. He says that Newton stated clearly that attraction was not a cause itself and that he did not know its cause. He defends Newton's argument that attraction was not occult but states that the *cause* of attraction might be. Fontenelle makes no final argument against or in defense of Newton's use of "attraction," but he does claim that it cannot be occult because its effects are so easily seen.[80] He also examines the difference between attraction and impulsion; he asks, if one is unsure whether attraction or impulsion is the appropriate term, why not call this force impulsion, as the term was not considered to be as occult as attraction was?[81] The same can be said for his attitude toward Newton's *Opticks*. He says that the best aspect of the book is that it provides an "excellent model for conducting experimental philosophy." He further describes Newton as the master of this empirical method, saying,

> If one would like to investigate Nature through experiments and observations, it will be necessary to investigate it in a manner as skilful and penetrating as M. Newton did.[82]

While Fontenelle doubts some aspects of gravitational attraction, he does not mean to dismiss other concepts, such as empirical observation, that were also associated with

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[79] Ibid., 165.

[80] Ibid., 163-4.

[81] Ibid., 157.

[82] "Quant on voudra interroger la Nature par les experiences, et les observations, il la faudra interroger comme M. Neuton, d'une manière aussi adroite, et aussi pressante." Ibid., 162.

Newton. Fontenelle's stance on these issues illustrates his complex position regarding Newton. He sees value in Newton's ideas and defends their merit, but he also questions some aspects. Fontenelle's position may be thought of as representative of other French academicians of his generation, who were interested in Newton's ideas, if reluctant to fully embrace them. The Academy's attitude toward Newton is significant for Rameau's own attempts to gain Academy approbation by making his work appear more Newtonian. Fontenelle's reaction demonstrates that adopting Newtonian characteristics was not likely to create success for Rameau with the Academy.

"Soft" Newtonianism

As Voltaire and others argued in favour of Newtonianism outside the Academy, more popularized versions of Newtonian science appeared in print, including a number of works apparently aimed at a female readership. Sarah Hutton has discussed how works such as Algarotti's *Le Newtonianisme pour les Dames* (1738) created a new public audience for science, and she addresses the claims that such easily accessible scientific knowledge was marketed toward women.[83] Hutton provides several examples of Newtonian works aimed at women that she feels were ultimately written for the general public, with "women" signifying the segment of the educated public with the least scientific expertise, including both men and women.[84] She focuses on Algarotti's work as an example of how such a market developed for accessible explanations of Newton's

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[83] Hutton, "Women, Science, and Newtonianism: Emilie du Châtelet versus Francesco Algarotti," 202.

[84] Ibid., 183-186.

work. Voltaire's *Lettres* can be thought of similarly as he avoids mathematical formulas in his explanations. Newtonianism (and experimental science) for women (and the general public) reflects Newton's own effort to write *Opticks* in simpler language, a phenomenon Hutton refers to as "soft" Newtonianism.[85] I believe Rameau's *Génération harmonique* could also be considered "soft" Newtonianism, an idea I will develop more fully in Chapters 3 and 4.

L'Encyclopédie

With its initial articles written nearly twenty years after the other sources discussed here, the *Encyclopédie* reflects the views of a younger generation of French intellectuals and Academy members, among whom Diderot and d'Alembert figure prominently.[86] The thrust of the articles in the *Encyclopédie* does not necessary reflect the Academy's views in the 1730s, but it transmits some of the results of the controversy over Newtonianism. By the time the first articles were published, Newtonianism had gained acceptance in the Academy and in the broader intellectual community. In Chapter 5, I provide a more detailed explanation of the process by which Newtonianism found acceptance in France. Here it is useful to see how terms like "Newtonianism" and "Cartesianism" appear in the *Encyclopédie*. I focus on a few entries that deal with Newton, Descartes, and their philosophies, as well as selected articles relating to music.

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[85] Ibid., 187.

[86] For more on the publishing details of the *Encyclopédie*, see Frank A Kafker, *The Encyclopedists as a Group: A Collective Biography of the Authors of the* Encyclopédie (Oxford: Voltaire Foundation, 1996) and Frank A. Kafker and Serena Kafker, *The Encyclopedists as Individuals: A Biographical Dictionary of the Authors of the* Encyclopédie (Oxford: Voltaire Foundation, 1998).

D'Alembert's article on "*Newtonianisme*" outlines the different uses of the term "Newtonian philosophy," and the divisions it caused between Cartesians, Leibnitzians, and Newtonians. Newtonianism, d'Alembert explains, may refer to physics, and as such it is simply a new philosophy, in the same vein as earlier, predominantly corpuscular philosophies such as those expounded by Descartes. Or it may refer to a new enthusiasm for observation and empiricism, in contrast to earlier philosophies in which the power of contemplation served as a useful starting point. Of course, observation and experimentation also play a role in Cartesian physics and philosophy, so to characterize Newtonianism as somehow more responsive to empirical observation is an over-simplification. Nevertheless, we can see here how d'Alembert found in Newtonianism a real imperative for empirically driven research. D'Alembert also notes that Newtonianism embraces the mathematics and geometry of physical bodies, and in this way is simply a mechanistic approach not altogether foreign to Cartesianism.[87] His comments remind us that "Newtonianism" encapsulated various philosophical practices and a group of overlapping but different perspectives.

In the same article, d'Alembert states that Newton's greatest achievement was his explanation of gravitational attraction through geometry and physics. These are at the heart of Newtonianism and were the primary targets for its opponents. D'Alembert claims some objected because the concept of attraction seemed somehow occult, as its cause was unknown, while others wanted to maintain loyalty to Descartes and his concept

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[87] Diderot and d'Alembert, *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, (Paris, 1751-1780; repr., Stuttgart-Bad: Cannstatt, Frommann, 1966), vol. 11, 122.

of vortices; still others did not believe in the void of space.[88] Regardless of the positions he describes, d'Alembert maintains a dry, neutral tone, one that treats Newtonianism without initially revealing his own orientations.

The article on "*Cartesianisme*" in volume 2, also by d'Alembert, provides a different perspective on Descartes than those found in Voltaire's or Maupertuis's writing. Unlike the article on Newtonianism, the article on Cartesianism gives a detailed account of Descartes's early life, his studies, his family and travels. Descartes in the *Encyclopédie* is much more human than in other accounts, and noticeably less tragic than in Voltaire's essay.[89] Of all the philosophers of his generation, d'Alembert argues, we owe Descartes the most. Because his method of inquiry was clear and others could use it, Descartes's work sparked a new curiosity among learned people. D'Alembert claims that because of Descartes, French physics was universally emulated and contributed to a number of great discoveries. Most interestingly, d'Alembert claims that Newtonianism is one of the fruits of Descartes's work — a statement that clearly distinguishes this article from the other writings discussed above.[90]

After discussing the details of Cartesian philosophy, d'Alembert says that Descartes had a difficult time finding wide acceptance in France. Further, by the time the article was published in 1752, he claims that Newton's work had superseded Descartes's physics. Since the rise of Newtonianism, d'Alembert says, all of the academic institutions had become "Newtonian" and many of the professors in Paris taught overtly English

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[88] Ibid., 125.

[89] Ibid.,vol. 2, 716.

[90] Ibid., vol. 2, 717.

philosophy.[91] Similarly, in the article on "*Cartésians*," he says that there were no longer any true Cartesians in the old sense of the word, no academicians who followed Descartes exactly.[92] By the 1750s, when the first volumes of the *Encyclopédie* were published, the "Newton wars" had died down. While some disagreement persisted regarding Cartesian vs. Newtonian philosophy or physics, Newton had gained wide acceptance. Newtonian philosophy was no longer as controversial as it was in Voltaire's day.

The *Encyclopédie* offers no specific entry for Rameau, but he is referenced in various other articles, particularly in Rousseau's entry on music where he is described as one of the best writers on speculative musical thought.[93] Rousseau's entry on harmony includes a discussion on rules for composition that are drawn from Rameau's work, and the author refers to the fundamental bass without citing Rameau. The authors of the *Encyclopédie* do not relate Rameau directly to Newtonian science; indeed by the time of the publication of the articles on music, Rameau's theoretical writing had taken up the *corps sonore* in ways that were largely uninflected by Newtonian thought.

Thomas Christensen has documented Rameau's hostile reaction to the musical articles in the *Encyclopédie*, which he had declined to write himself.[94] Rameau openly criticized Rousseau's handling of the material,[95] even though some of Rousseau's articles

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[91] Ibid., vol. 2, 725.

[92] Ibid., vol. 2, 726.

[93] Ibid., vol. 10, p. 902.

[94] Christensen, *Rameau and Musical Thought in the Enlightenment*, 247.

[95] Ibid., 209-210.

are generally quite generous to Rameau.[96] Rameau's reaction may have been rooted in his previous disputes with Rousseau, before the publication of the *Encyclopédie*; in general, these disputes concerned French operatic conventions and the relationship between melody and harmony.[97] However, after the *Encyclopédie* was published, Rameau published his own anonymous pamphlet in which he criticized many of Rousseau's musical articles.[98] Rameau only had the chance to respond to the musical entries in the first few volumes of the *Encyclopédie* as many of the articles on music were published after his death in 1764.

The Newton Wars?

Historians are not in uniform agreement on whether it is fair to characterize the debates over Newtonianism in the 1730s as a figurative war. Certainly Shank believes that the debates over Newtonian philosophy were especially heated and were symptomatic of a significant cultural shift in France during that time. As examples, he cites Voltaire's *Lettres*, which drew a strongly negative reaction from the government. He also cites Maupertuis and the growing interest in Newtonianism in the Academy, even as Fontenelle and others like him defended their earlier philosophical methods. Perhaps Shank's most accurate description comes from one of his chapter headings, titled "A French Culture War." The debate often centered on whether or not to accept Newton and therefore English philosophy, and whether in turn that meant a rejection of Descartes and

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[96] Ibid., 248.

[97] Ibid.

[98] Ibid., 249.

French philosophy. Mordechai Feingold's scathing review of Shank's book opposes many aspects of Shank's work. Feingold takes particular issue with the notion that Newtonian ideas were so polemical in France in the 1730s as to cause such a war, as most of Newton's ideas had been introduced to French academic culture decades earlier.[99] Israel suggests further that we should not take Voltaire literally when he describes the conflict between Cartesians and Newtonians, because he refers to anyone he perceives to be his enemy as a Cartesian.[100]

Whether or not the debates should be characterized as a metaphoric war, we can be certain that an intellectual, epistemological shift did occur at the time, and not without the difficulties that accompany such change. From Voltaire's and Maupertuis's writings it is apparent that they situated themselves and their work carefully, anticipating public and academic invective, such as Castel's. Evidence of an earlier conflict is also suggested in many articles from the *Encyclopédie*, as the authors refer to Newton's work as having changed the prevailing views on Cartesian philosophy, indicating that the conflict had been resolved. It is helpful to attempt to understand the terms of this debate in order to appreciate the tension it caused for Rameau in his writings of the 1730s, particularly *Génération harmonique*.

There is no doubt that intellectual debates took place during the 1730s; this was the decade in which Voltaire's *Lettres* was banned and Maupertuis's book was criticized rigorously by Castel. Whether or not we see those debates as a true culture war, we can say that the prominent thinkers of the day engaged in vigorous debates that drew

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[99] Feingold, "The War on Newton," Review of *The Newton Wars* by J. B. Shank," 175-186.

[100] Jonathan Israel, *Enlightenment Contested*, 261.

enthusiastic and at times polemical reactions from both sides. From my own reading of Voltaire's *Lettres* and the other sources discussed here, I am convinced that positioning Newton in opposition to Descartes is too simple a way of understanding this debate. Rameau interacted with some but not all of the authors discussed here and so an understanding of their positions sheds light on Rameau's own work at the time.

Chapter 3: Rameau, Newtonianism, and Experience

Having outlined the major contributions and reactions to French Newtonianism, I now turn to Newtonianism as it manifests in the first chapter of Rameau's 1737 treatise *Génération harmonique*: propositions and experiments. This part of Rameau's work draws heavily on similar experiments performed by Dortous de Mairan (1668-1771), who was interested in Newton's corpuscular theory of light, as explained in *Opticks* (1704). Mairan, who was often regarded as a Cartesian,[1] applied this theory to the domain of sound. His corpuscular theory of sound drew Rameau's attention and he and Rameau developed a friendship.[2]

Rameau proposes a series of experiments that he argues will prove the natural existence of the *corps sonore*. Through several hands-on tasks, Rameau asks readers to strike objects near their ears or to observe vibrating strings in order that they might understand the upper partials of the *corps sonore* above the fundamental. Rameau's use of experiments indicates a larger connection between his work and other Newtonian texts written after 1700. The experiments and their conspicuous placement at the beginning of the treatise are the most overtly Newtonian characteristics of *Génération harmonique*. The empirical knowledge gained from the experiments is meant to serve as the basis for his entire theory. As with other Newtonian texts, including Newton's *Opticks*, Rameau used mostly everyday materials such as string, wood, and toothpicks. Rameau's treatise is also similar to other Newtonian documents in that he presents his experiments in an

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[1] Though Mairan was interested in Newtonian physics, his epistemology was fundamentally Cartesian. See Shank, *The Newton Wars*, 99-101.

[2] Christensen, *Rameau and Musical Thought in the Enlightenment*, 139.

accessible rhetorical style, easily understood by non-scientists. Through these experiments, Rameau may have sought to align his work with that of other experimental scientists of the time, many of whom were associated with Newtonianism. In some cases, especially in the 1730s, these mathematicians and physicists self-consciously considered themselves Newtonians and sought to spread knowledge of Newton's works throughout Europe. In other cases, certain individuals were interested in particular aspects of Newton's work and attempted to implement some or all of his methods without attempting to disseminate Newtonianism in general. Whether these authors desired to be grouped together as "Newtonians" is unclear.

The experiments in *Génération harmonique* do more than simply prove the natural existence of the *corps sonore*. On the one hand, Rameau used experiments to physically validate what he believed to be mathematically (i.e., abstractly) true about the *corps sonore*. On the other hand, the circumstances of his work on *Génération harmonique* indicate that he may have been drawn to the increasing social and scientific authority of the French Newtonians and their methods, including experimental science, in the 1730s. Rameau never states outright his desire to use Newtonianism to establish his reputation, nor does he cite any scholarship branded as Newtonian. But it is worth considering how such potential benefits may have influenced his decisions about how best to present his theory. In order to know how Rameau stood to benefit from portraying his harmonic theory as linked with Newtonian science, we must understand the context in which Newtonian experimental science gained prominence and the different reactions to it.

Rameau's relationship with Mairan significantly impacted his use of experiments and their reception, as Mairan was responsible for Rameau's understanding of corpuscular sound theory on which he based his experiments. Mairan hoped to demonstrate that sound was composed of particles that vibrated at various frequencies, just as Newton had demonstrated with light.[3] Different sonic particles come together, according to Mairan, to form sound, just as Newton had theorized that white light was a composite of smaller particles of various colours.[4] Mairan's theory of composite sound would have obviously appealed to Rameau, as it seemed to validate his theory of the *corps sonore* and its upper partials.

We can see Rameau's use of Mairan's ideas as part of his attempt to appeal to readers both inside and outside the Academy. As Mairan was a member of the Academy and a Cartesian, Rameau may have hoped that a relationship between his own work and Mairan's would elevate his status with Academy members. However, as I discuss below, his reviewers suspected his motives and criticized his intentions. Reviewers of *Génération harmonique* frequently commented on the relationship between Rameau's work and Mairan's and on the relationship between Mairan's and Newton's. They reacted strongly to Rameau's use of science and experiments in his theory of harmony; reflecting this, contemporary reviews of *Génération harmonique* also feature prominently in this chapter.

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[3] Dortous de Mairan, "Propogation du Son dans les différentes Tons qui le Modifient," *Histoires de l'Académie Royale des Sciences-Mémoires* (1737): 3.

[4] Ibid.

Mairan and Rameau

Dortous de Mairan entered of the Academy in 1718 and quickly rose through the ranks to become a full Academy member two years later. By 1728, the Crown had paid for him to live in a suite of rooms in the Louvre with other high-ranking academicians.[5] Later, in 1740, Mairan became Academy Secretary.[6] From these biographical details we can surmise that his authority within the Academy was significant. Though he was a lifelong advocate for Cartesian mechanics,[7] Mairan's methodological identity is somewhat confusing and complicates the Newtonian versus Cartesian binary so often used to describe authors of this period. Mairan's work wavered between the two approaches. He was interested in empiricism as Newton practiced it, and he believed in the validity that could be obtained through empirical data; hence his interest in Newton's *Opticks*.[8] Mairan's professional reputation serves as an example of the danger of strictly applying the "Newtonian" or "Cartesian" labels. J. B. Shank argues that Mairan was also concerned with keeping up a certain public image; he went to salons[9] and was frequently seen with the Academy's Secretary, Bernard le Bovier de Fontenelle, and other French Academicians. As he ascended in academic status, Shank claims, Mairan was aware of

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[5] Shank, *The Newton Wars,* 101.

[6] Ibid.

[7] Ibid. For more details of Mairan's life, see: Abby Rose Kleinbaum, "Jean-Jacques Dortous de Mairan (1678-1771): A Study of an Enlightenment Scientist."

[8] Ibid., 102.

[9] Shank, *The Newton Wars*, 103. On this point, Shank cites Pierre-Maurice Masson, *Madame de Tecin (1682-1749): Une vie de fmme de XVIIIe siècle* (Paris: Hachette, 1910), 194; and Roger Marchal, *Madame Lambert et son milieu* (Oxford: Voltaire Foundation, 1991), esp. 241-243.

the need for the proper balance between intellect and sociability, as public image became more important in French intellectual society.[10]

Despite Mairan's later refutation of the charge that Rameau exploited their relationship, I believe Rameau was not insensitive to the potential benefits of citing Mairan. Rameau was too astute to ignore the kind of institutional power that Mairan had and he frequently sought endorsement for his theories from prominent scientists of the day. Thomas Christensen writes, "Rameau never concealed his ambition to elevate music theory to the stature of a fully scientific enterprise."[11] His success in elevating music theory could reap great benefits for his reputation as an intellectual. If he were to seek support from an influential mathematic and scientific thinker, then Mairan, with his connections to the Crown and the Academy, would have been the ideal candidate. Furthermore, Mairan would have recognized the Cartesian aspects of Rameau's earlier work. Both Rameau and Mairan maintained an allegiance to certain Cartesian principles even after taking an interest in Newtonian science. Mairan probably did think of their relationship as purely academic and collegial; however, Rameau's motives were also likely more complicated.

In 1737, Mairan presented to the Academy his essay, "Propogation du son dans les différentes tons qui le modifient," in which he argued that Newton's concept of corpuscular light could also apply to sound. Mairan refers to Newton in his explanation of sonic corpuscles, yet he says that any comparison between himself and Newton only

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[10] Ibid., 104.

[11] Christensen, *Rameau and Musical Thought in the Enlightenment*, 9.

flatters his own work, as he only imitated Newton.[12] As others have noted, Mairan cites Rameau:

> But I could, moreover, avoid entering [this discussion of corpuscular sound] in detail, especially since a celebrated musician of today for whom these ideas and my hypothesis are not unknown, will shortly publish a Treatise on Music that aims at this goal, and which is based on these same principles.[13]

In "Propogation," Mairan cautiously suggests a correlation between light and sound, based on the frequencies of their vibrations:

> But one of the chief items of similarity of light and sound must be, if I am not mistaken, that of the various vibration speeds that alter them, the one in its colours, the other in its pitches. [14]

Newton himself suggested a similar concept to explain how the eye perceives different colors:

> May not the harmony and discord of Colours arise from the proportions of the Vibrations propagated through the Fibres of the optick Nerves into the Brain, as the harmony and discord of Sounds arise from the proportions of the vibrations in the Air? For some Colours, if they be view'd together, are agreeable to one another, as those of Gold and Indigo, and others disagree.[15]

However, by the end of "Propogation," Mairan does not take a firm position on whether such a correlation between light and sound is valid. He simply wants to discuss whether their correlation is possible: "I would not be able here to account for the analogy that has

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[12] Dortous de Mairan, "Propogation du Son," 3.

[13] "Mais je puis d'autant plus me dispenser d'entrer là dessus dans le détail, qu'un célebre Musicien de nos jours, à qui ces idées et mon hypothese ne sont pas inconnuës, va donner incessamment au Public un Traité de Musique qui tend à ce but, et qui porte sur ces mêmes principes." Ibid., 14.

[14] "Mais l'un des principaux articles du parallele de la Lumiére et du Son doit être, si je ne me trompe, celui des différentes vîtesses de vibration qui les modifient, l'une dans ses couleurs, l'autre dans ses tons." Ibid., 23.

[15] Isaac Newton, *Optick*, 345-46.

been believed to exist between light and sound.**"**[16] Mairan adds that refraction does not work the same way in light as in sound, thus weakening their comparison. Though he did not wholeheartedly embrace Newton's idea of the correlation between light and sound, in this text he nevertheless praises Newton's achievements.[17]

Rameau cites Mairan and refers to their relationship in Proposition 3 of *Génération harmonique*, dealing with particles of sound:

> Ten or twelve years ago, M. de Mairan, the mere mention of whose name is cause for praise, while reasoning with me on my system, communicated to me this reflection on the particles of air. He explained his idea to me in great detail, in conformance with what had been reported in the *Mémoires de l'Académie des Sciences*, for the year 1720, page 11. But, as I was not yet concerned with that area, I did not know how to profit from this idea and I even forgot it, until M. de Gamaches reminded me of what M. de Mairan had said. And through good fortune, for which I cannot sufficiently acknowledge him, I was made to sense the relation of this principle to those on which I had already founded my system to so great an extent that I finally appropriated it.[18]

Again, Rameau's descriptions of Mairan's work and their interactions give some indication that he wanted to use his relationship with Mairan specifically to enhance his

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[16] "Je ne sçaurois tenir compte ici de l'analogie qu l'on a cru voir entre la Lumiére et le Son." Mairan, "Propogation du Son," 37.

[17] In addition to Mairan's treatment of Newton in this essay, we can see his general response to Newtonian physics in his correspondence with Voltaire. Over the course of a few letters, Voltaire attempted to persuade Mairan to embrace Newtonian concepts such as gravitational attraction. In each case, Mairan politely argued against Voltaire's Newtonian perspective. See for example: Voltaire [François Marie Arouet]. "*Voltaire [François Marie Arouet] to Jean Jacques Dortous de Mairan: Thursday, 11 September 1738 — [letter]*." Letter voltfrVF0890286_1key001cor of *Electronic Enlightenment*. Ed. Robert McNamee et al. Vers. 2.4. University of Oxford. 2013. Web. 28 Jan. 2014. <http://www.e-enlightenment.com.proxy1.lib.uwo.ca/item/voltfrVF0890286_1key001cor/>.

[18] "Il y a dix ou douze ans que M. de Mairan, dont le nom seul fait l'éloge, raisonnant avec moi sur mon sistême, me communiqua cette réflexion sur les particules de l'Air, qu'il m'expliqua son idée fort en détail, conformément à ce qui en a été rapporté dans les Mémoires de l'Académie des Sciences de l'année 1720, pag. 11. Mais n'ayant pas encore les vûes tournées de ce côté-là, je ne sçus pas en profiter et je l'avois même oublié, lorsque M. de Gammaches me rappella ce que m'avoit dit M. de Mairan; et par une bonté dont je ne puis trop lui témoigner ma reconnoissance, me fit si bien sentir le rapport de ce principe avec ceux sur lequels j'avois déja fondé mon sistême, que je me le suis enfin approprié." Rameau, *Génération harmonique*, 3-4; Hayes, "Rameau's Theory of Harmonic Generation," 29-30. Throughout this dissertation I will use Hayes's translation of *Génération harmonique* unless otherwise specified.

reputation. He draws our attention to their friendship at the beginning of the paragraph by vaguely describing how long he has known Mairan. He neglects to mention Mairan until the third proposition, though all the propositions were based on Mairan's ideas. By treating Mairan this way, Rameau attempts to shift the ownership of these ideas to himself. By beginning his propositions without mentioning Mairan, Rameau implies that the propositions are his alone. Moreover, there is the implication of Mairan's endorsement of the propositions in *Génération harmonique*.

Deborah Hayes asserts that Rameau's use of experiments signals his desire to be seen as an intellectual. She says that *Génération harmonique* was his bid for acceptance into the Academy and that it was the only work he specifically dedicated to the Academy. Hayes further cites Rameau's acquaintance with Mairan as one of the primary catalysts for his interest in Academy membership.[19] Perhaps because of Mairan's interest in his theory, Rameau began to see the Academy as a productive channel for his success.

Rameau's Propositions and Experiments

Experimental methodology plays a more significant role in *Génération harmonique* than in any of Rameau's other theoretical writings. Though Rameau references scientists and thinkers like Descartes and Joseph Sauveur (1653-1716) in *Traité de l'harmonie* (1722) and in *Nouveau système* (1726), his use of propositions and experiments to introduce and legitimize his theories is unique to *Génération harmonique*.[20]

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[19] Hayes, "Rameau's Theory of Harmonic Generation," 284-85.

[20] This chapter centers on Rameau's experiments as Newtonian aspects of *Génération harmonique*. In Chapter 4, I will focus on other Newtonian characteristics of this treatise.

The first chapter of *Génération harmonique* deals with a series of twelve propositions and seven related experiments that are designed to demonstrate the existence and natural origin of the *corps sonore*. His propositions focus on how particles of air vibrate in sympathetic proportion to the sound source and each experiment is meant to demonstrate this through observable phenomena. After explaining each experiment, Rameau indicates which proposition it confirms.[21] By the time he wrote *Génération harmonique*, Rameau believed he could explain the existence of the *corps sonore* rationally, thus pleasing his Cartesian readers. The experiments, however, were designed so that anyone who performed them would have his or her own empirical evidence of the *corps sonore* and its principles. His use of empiricism would potentially have had broader appeal to the younger group of academicians who were interested in or at least open to Newton's theories, as well as to members of civil society, who had a growing appetite for accessible experimental science.[22]

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[21] For example, Rameau's eleventh proposition states that there are pitches that are either too low or too high for our ears to perceive. He says that Experiment 5 corresponds to Proposition 11, as the reader is asked to listen to one of the highest or lowest pipes on the organ and observe that they cannot hear the pitch it produces. He concludes that this is because they exceed the range of pitch discrimination by the ear. See Rameau, *Génération harmonique*, 7-17; Hayes, "Rameau's Theory of Harmonic Generation," 33-44.

[22] Throughout this chapter I refer to the "public" as Thomas Broman discusses it in his article, "The Habermasian Public Sphere and 'Science *in* the Enlightenment," *History of Science*, xxxvi (1998): 127. Broman defines the public as "members of civil society," typically demarcated by their economic class, whose members create the public sphere through self-expression, for example, in newspapers. Broman claims that new cultural centers such as coffee houses gave the impression that patrons would have equal opportunity to participate in public discourse, though in reality it was mostly white, wealthy men who had the power to express themselves publically. Among the topics of discussion in the new public sphere, Broman lists science. For more on the popularization of Newtonianism and science in general among the public, see Sarah Hutton, "Women, Science, and Newtonianism: Emilie du Châtelet versus Francesco Algarotti," passim.

As interest in empirical science increased among experts, the participation among lay people in scientific activities also grew during this time.[23] Experimental philosophy had become the most *en vogue* intellectual activity for the wealthy, according to Voltaire. He writes,

> Verses are hardly fashionable any longer in Paris. Everyone begins to play the geometer and the physicist. Everyone meddles in reasoning. Sentiment, imagination and charm are banished. It is not that I am vexed that philosophy is cultivated, but I should not want it to become a tyrant that excludes everything else.[24]

Treatises that featured experimental science that could be performed in the homes of the educated public thus had broad appeal. According to Voltaire's (slightly ironic) testimony, the "public" refers to educated, fairly wealthy members of society, mostly (though not always) men. These educated non-experts created a new market for writings like Newton's. Shank and others point out that, significantly, the Academy was not directly responsible for this trend.[25]

As Rameau's experiments have been compared to those in Newton's *Opticks*,[26] it is necessary to understand how *Opticks* figured into eighteenth-century English and French reading culture. Newton originally published *Opticks* in English in 1704; a Latin

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[23] Shank, *The Newton Wars*, 154-155.

[24] "Les vers ne sont plus guère à la mode à Paris. Tout le monde commence à faire le géomètre et le phisicien. On se mêle de raisoner. Le sentiment, l'imagination et les graces sont bannies. Ce n'est pas que je sois fâché que la philosofie soit cultivée, mais je ne voudrois pas qu'elle devint un tiran qui exclût tout le reste." *Voltaire's Correspondence*, ed. Theodore Besterman, 107 vols. (Geneva: Institut et muse Voltaire, 1953-65), IV (1954), no. 838, 48-49. As quoted and translated in: Henry Guerlac, *Essays and Papers in the History of Modern Science*, 131. I have adjusted Guerlac's translation slightly.

[25] Shank, *The Newton Wars*, 154-155. See also: Sarah Hutton, "Women, Science, and Newtonianism,"183-203

[26] See Christensen, *Rameau and Musical Thought in the Enlightenment*, 142-46.

translation appeared in 1706. French Academicians (and others, for that matter) who did not read English had access to the Latin version, which was reviewed in the *Journal des Trévoux* in 1709.[27] Pierre Coste published the first French translation in 1720, thus making it available to a wider French audience. According to I. Bernard Cohen, the general interest in *Opticks* was partly due to the success of Newton's previous work, *Principia*, in which Newton had briefly discussed gravitational attraction but stated that he could not yet know its cause. Cohen argues that those who had read or were familiar with the claims in *Principia* had eagerly awaited further discussion on the cause of gravity.[28] Though the main thrust of *Opticks* was Newton's theory of light, Newton included thirty Queries near the end of the book that provided further discussion of his theory of gravitational attraction.[29] Further contributing to the anticipation surrounding *Opticks* was the more accessible nature of the book. Though *Principia* was regarded as monumental, few among the educated public had actually read it. Intellectual members of society welcomed a version of Newton's work that was unencumbered by dense calculations.[30] In addition to the discussion of gravity and accessible language, Cohen suggests that *Opticks* drew a large readership because of its wide range of topics, including theology and art. Cohen writes:

> "Here, then, was a rich intellectual feast for philosophers as well as scientists, for poets as well as experimenters, for theologians as well as painters, and for all

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[27] Shank, *The Newton Wars*, 113.

[28] I. Bernard Cohen, introduction to *Opticks*, by Isaac Newton, xxvii-xxxii.

[29] The Queries near the end of *Opticks*, Book III, Part 1, deal especially with gravitational attraction and the implications Newton believed it held for all disciplines. See especially Queries 18-30 in Newton, *Opticks*, 348-406.

[30] Ibid., xxvii-xxviii.

> amateurs of the products of the human imagination at its highest degree of refinement."[31]

In this way, *Opticks* appealed to the educated public beyond the scientific community.

In describing Newton's work in *Opticks*, Cohen also draws attention to Newton's portrayal of himself as both theoretician and experimenter. He writes, "It is rare that the two are combined within one individual as they were in Newton."[32] Cohen continues that Newton's image in *Principia* was that of a mathematician. But in *Opticks*, Newton was:

> exploring new fields depending on empirical investigation for their future progress…The mentor and guide of those who explored these new fields was Newton the heroic experimenter of the *Opticks* and the author of the *Queries*.[33]

As few but the most expert mathematicians would have read *Principia*, Cohen argues, Newton's image in *Opticks* would have attracted the attention of the educated public, hence his appeal to figures like Voltaire, and possibly, Rameau.[34]

In order to compare Newton's experiments with Rameau's, I focus on three features of the experiments in *Opticks* that appear in *Génération harmonique*. First, Newton frequently employs household, everyday items, such as soap bubbles, coal, or pieces of paper. While he also uses some specialized instruments, such as prisms, the use of these commonplace objects adds to the accessibility of the experiments; readers would not need access to a laboratory in order to participate. Adding to the sense of accessibility, Newton also invites the reader to use their sensory organs in the

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[31] Ibid., xxxvi.

[32] Ibid., xxxvii.

[33] Ibid., xxxviii.

[34] Ibid., xxxviii.

experiments. For example, Newton asks readers to touch their eyes in Query 16, Book Three, Part 1 of *Opticks*:

> When a Man in the dark presses either corner of his Eye with his Finger, and turns his eye away from his Finger, he will see a Circle of Colours like those in the Feather of a Peacock's Tail. If the Eye and Finger remain quiet these Colours vanish in a second Minute of Time, but if the Finger be moved with a quavering Motion they appear again. Do not these Colours arise from such Motions excited in the bottom of the Eye by the Pressure and Motion of the Finger, as, at other times are excited there by Light for causing vision?[35]

Newton's language is also approachable in *Opticks*, as he gives rather inexact descriptions of his own experience performing the experiments. For example, the experimental sections in *Opticks* do not contain dense calculations. In Book 1, Newton refers to an experiment he performed with a prism and a piece of paper, meant to demonstrate the refraction of "homogeneal" light: "In the middle of a black Paper I made a round Hole about a fifth or sixth Part of an Inch in diameter." He goes on to say that he held the prism so that the light hit the paper from two or three feet away.[36] Newton is purposefully inexact in his instructions here, likely because imprecision did not greatly affect the outcome of the experiment. Yet Newton also seems to have understood that non-expert readers would find it easier to imagine performing the experiments if the details (the width of the hole, the distance from the prism to the paper) did not need to be perfectly exact in order to reproduce a meaningful result. This casual, approachable tone was likely appealing to authors seeking to adopt a Newtonian stance.

Rameau's experiments resemble those of Newton's *Opticks* in several ways. They combine musical instruments and household items, just as Newton's combine such items

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[35] Newton, *Opticks,* 347.

[36] Ibid., 73.

with specific scientific instruments. For example, Rameau uses a monochord in the first experiment to demonstrate string harmonics. He then recommends that the reader use a toothpick to stop the string at one point and then pluck it on one side of the stop, in order to hear the sympathetic resonance of the other side.[37] While other experiments draw on musical instruments (such as the violoncello or organ) that only a trained musician would have used, most of his readers would have had at least a cursory knowledge of the look and sound of these instruments. Several of the experiments focus entirely on everyday items to which most readers would have had access. Rameau's Experiment 6 reads as follows:

> Suspend a pair of tongs[38] from a fairly thin string, each end of which you apply to each ear. Strike it. You will distinguish at first only a confusion of sounds, preventing you from being able to perceive the pitch of any of them. But as the higher sounds become extinguished imperceptibly as the sound diminishes in strength, the lowest sound, the sound of the whole body, begins to predominate in the ear.

He goes on,

> When the pair of tongs no longer sounds, blow on it as hard as you can. You will hear, at first, the same confusion, but it will vanish much faster, so that you can hear what has just been explained.
> When the ends of the string are no longer applied to the ear, the ear will not distinguish any sound in the pair of tongs when it is blown on. And the great noise that affected the ear at first, when the pair of tongs was struck, will seem much less, and much higher, without the ear ever being able to perceive above it. This not only proves that any body set in motion is capable of sounding, but also that sound which seems not at all perceptible as to pitch may well be a perceptible

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[37] Rameau, *Génération harmonique*, 7-8; Hayes, "Rameau's Theory of Harmonic Generation," 34.

[38] Hayes translates this word, "Pincette," as "tweezers." I have translated it instead as "tongs," though they would likely have taken a shape similar to a large pair of tweezers or forceps. For more on the history of such medical instruments, see: John Kirkup, "The History and Evolution of Surgical Instruments," *Annals of the Royal College of Surgeons of England* 78 (1996): 544-552.

> pitch if the ear can distinguish, in the sound, everything that constitutes its harmony.[39]

Other variations of this experiment involve replacing the string with twine or catgut and touching it with pieces of wood or iron. Just as Newton asked the reader to observe the colours produced by inserting a finger into their eye, Rameau asks the reader to use their auditory senses to verify the results of this experiment.

Rameau is inexact in his instructions for various experiments, just as Newton took a more relaxed tone in describing his. In Experiment 1, which demonstrates sympathetic resonance on a monochord, he directs the reader:

> Take a monochord, and divide its string into as many equal parts as you wish. Apply a light obstacle, such as the point of a toothpick, at one of the divisions, but in a way that there are more divisions on one side than the other. Pluck the string on one side.[40]

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[39] "Suspendez une Pincette à un Cordon un peu mince, dont vous appliquerez chaque bout à chaque Oreille; frappez-la, vous n'y distinguerez d'abord qu'une confusion des Sons, qui vous empêchera d'en pouvoir apprétier aucun: mais les plus aigus venant à s'éteindre insensiblement, à mesure que la résonnance diminue de force; le plus grave, celui du Corps total, commence à s'emparer de l'Oreille." […] "Lorque la Pincette ne résonne plus, soufflez dessus le plus fort que vous pourez, vous y sentirez d'abord la même confusion, mais qui se dissipera beaucoup plus promptement, pour vous laisser entendre ce qui viente d'être expliqué. Lorque les bouts du Cordon ne seront plus appliqués à l'Oreille, elle ne distinguera pour lors aucun Son dans la Pincette à l'occasion du soufflé, et ce grang bruit don't elle d'abord été affectée, en frappant cette Pincette, lui paroîtra beaucoup moindre and beaucoup plus aigu, sans qu'elle puisse jamais l'apprétier: ce qui prouve que, non-seulement tout Corps mis en mouvement est capable de résonnance, mais encore que tel Son qui ne paroît point apprétiable, pourroit bien l'être, si l'Oreille pouvoit y distinguer tout ce qui en constitue l'Harmonie." Ibid., 17-18; Hayes, 45-46. Hayes infers the word "pitch" in these passages where it is not literally present, even though Rameau is fairly ambiguous. I have not altered this translation, however, believe that her interpretation of this passage is correct.

[40] Prenez un Monocorde dont vous diviserez la corde en autant de parties égales que vous le jugerez à propos; appliquez un obstacle léger, comme la pointe d'un curedent, à l'une de ces divisions, de maniere cependent qu'il y ait un plus grand nombre de parties d'un côté que de l'autre; pincez l'un de ces côtez." Rameau, *Génération harmonique*, 7-8; Hayes, "Rameau's Theory of Harmonic Generation," 34. Here I have translated "jugerez à propos" differently from Hayes' translation "as you wish." Rameau's wording emphasizes the reader's ability to judge for him or herself how best to complete the experiment.

He calls for the reader of Experiment 3 to "Bow one of the larger strings of a viol or violoncello."[41] In Experiment 2 he writes, "Take a viol or violoncello. Tune two of its strings a twelfth apart."[42] Rather than stating specifically which string to use, Rameau leaves that choice to the reader, just as Newton did not specify exact distances or measurements in his experiments. In both cases, the inexact instructions do not affect the outcome for the experiments. The casual tone here is certainly reminiscent of that in Newton's *Opticks*, in that it would have appealed to a non-expert readership.

Despite their similarities, the role of experiment in *Opticks* is far different from that in *Génération harmonique*. The experiments in *Opticks* are crucial, and they are introduced throughout the text. For Rameau, on the other hand, experiments are restricted to the first chapter and then abandoned. Rameau hoped that in using the experiments he could make a scientific case for the *corps sonore*, and that he could establish its natural origin and existence through empirical proof. On this basis, he hoped that his whole system might be considered scientifically valid.

Rameau's use of experiments also illuminates the new role of experience in his theoretical work. In each experiment, Rameau asks the reader to observe something: to listen for the sympathetic resonance of the strings, the sound corresponding to different amounts of air in the trumpet or organ pipe, or the sounds produced by the tongs held by a string next to her or his ears. Throughout *Génération harmonique*, the "Ear" is a signifier for aural experience. Rameau conceives of the "Ear" as a conduit to the mind,

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[41] "Raclez une des plus grosses cordes d'une Viole, ou Violoncello." Ibid., 10; Hayes, 38.

[42] "Prenez une Viole, ou un Violoncello, dont vous accordez deux cordes à la Douziéme l'une de l'autre." Ibid., 8; Hayes, 36.

capable of receiving and interpreting rational information.[43] Rameau's Ear functions much like Newton's "Eye." Newton anticipated that readers who performed his experiments could verify their results by observing the colors around them. In *Génération harmonique*, Rameau's Ear performs similar work, providing aural confirmation of musical phenomena. For example, the Ear is particularly prominent in Rameau's discussion of temperament. The Ear, according to Rameau, validates his use of equal temperament because it cannot perceive the small discrepancies with other popular temperaments.[44] He writes that the Ear cannot immediately recognize these small differences because these pitches are so far removed from the fundamental that gave rise to them:

> For all its [the Ear's] capabilities in harmony derive directly and immediately from the resonance of the *corps sonore*, which cannot help it out in this latter judgment.[45]

Rameau first pays special attention to the Ear in *Nouveau système*, saying that the reasoning of the Ear cannot be fully trusted; the fact that the Ear relies on experience means that its capacity for reason is suspect.[46] In fact, as Glenn Chandler argues, Rameau's references to the Ear in *Nouveau système* can be understood as an example of

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[43] For more on Rameau's concept of the Ear-as-mind, see: David E. Cohen, "The 'Gift of Nature': Musical 'Insinct' and Musical Cognition in Rameau," in *Music Theory and Natural Order from the Renaissance to the Early Twentieth Century* (Cambridge: Cambridge University Press, 2001).

[44] Ross W. Duffin argues that these differences are, in fact, perceptible. For more on the history of equal temperament and its effect on musical practice, see Ross W. Duffin, *How Equal Temperament Ruined Harmony (and Why You should Care)* (New York: W. W. Norton & Co., 2007), passim.

[45] "Car toutes ses faculties en Harmonie naissent directement et immédiatement de la résonnance du Corps sonore, qui ne peut lui faciliter cette dernier apprétiation." Rameau, *Génération harmonique*, 53. This particular translation is my own.

[46] Chandler. "Rameau's *Nouveau système de Musique Theorique:* An Annotated Translation with Commentary," 194.

his Cartesian orientation, as he doubts the validity of experience.[47] In *Génération harmonique*, however, this same concept takes on new meaning. Rameau suggests that the Ear works together with our faculties of reason:

> The judgment of the Ear is always well-founded, and, completely obscure as it is without the aid of reason, it nevertheless adds to the insights of the latter when it once has developed the causes of this judgement in us. It is for us a double confirmation thus to see reason and the Ear in tune with each other.[48]

Rameau similarly references the fundamental bass "guiding" the Ear, and the Ear confirming what we know to be mathematically true about music. Rameau's reliance on the Ear to confirm his arguments signals the new importance of experience in *Génération harmonique*.

In discussing Rameau's use mathematics, Deborah Hayes and others have pointed out the errors, mathematical or otherwise, in Rameau's explanations.[49] In a way, however, his readers' ability to notice his mistakes is more important than the accuracy of his mathematics. The Academy members who read his work surely detected its errors, but many other readers likely did not. Rameau's mistakes indicate that his work is, at best, pseudo-scientific. Hayes points out the difference between Rameau's theory of harmony, which was informed by science, and Sauveur's work on acoustics, which can actually be called science. She says that Rameau offers numerical representations of

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[47] Ibid.

[48] "Le jugement de l'Oreille est toujours fondé, et tout obscur qu'il est sans le secours de la raison, il ajoute cependant aux lumieres de cell-ci, quand une fois elle nous a développé les causes de ce jugement: c'est pour nous une double confirmation de voir ainsi la Raison et l'Oreille s'accorder ensemble." Rameau, *Génération harmonique*, 78; Hayes, "Rameau's Theory of Harmonic Generation," 103. I have slightly adjusted Hayes's translation here.

[49] Hayes, "Rameau's Theory of Harmonic Generation," 284. Hayes argues that the Encyclopedists were immediately aware of the errors in the theory (including string divisions) behind Rameau's experiments.

pitches but does not actually calculate anything. Rameau only provides interval ratios (in a manner not unlike Zarlino) rather than actual string lengths or vibration frequencies as he had done in *Traité*. He is able to make his work appear scientific without it truly being so.[50] Hayes ultimately concludes that Rameau was a failed scientist, lacking expert knowledge of up to date developments.[51] She states that his popular reputation as the "Newton of Music" was intended as praise for his musical skills as a Frenchman and his music-theoretical innovations; his scientific achievements did not merit such a comparison.[52] The validity of his scientific claims notwithstanding, we can still speculate as to his motives for using scientific methods at all.

Génération harmonique and Other Newtonian Writings

Identifying the methods and characteristics in representative writings helps to situate Rameau within the larger trend of French Newtonianism. Each of the texts below has been considered Newtonian in some way, but it is important to note the great variety in their content and methods. In some cases, the author sought to disseminate Newtonianism or to attract non-expert readers. Other authors employed experiments or the concept of gravitational attraction in their work without explicitly naming Newton. Each of these writings can shed light on *Génération harmonique*, and by noting their intersections we can understand Rameau's work as part of a body of scholarship that made up French

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[50] Ibid., 301-2.

[51] Ibid., 264.

[52] Ibid., 263-64.

Newtonianism. I will discuss these works chronologically to track the development of French Newtonianism during the first three decades of the eighteenth century.

In cases where the author neglects to refer directly to Newton, we can often discern the author's Newtonian characteristics by observing Fontenelle's reactions. As a staunch Cartesian, Fontenelle was especially alert to the Newtonian characteristics in these writings, yet he sought to preserve objectivity in his assessments. Nevertheless we can see from his comments that the Cartesian establishment did not approve of the increasing interest in empiricism that Newtonianism brought with it.

The work of French scientist Saulmon is a useful example of experimental science written in language that was accessible to lay people.[53] In 1714, Saulmon's study of vortices, "Expériences sur des corps plongez dans un tourbillon," was published in the *Histoires de l'Académie des Sciences*.[54] Though experimental science was already a part of scientific enquiry, it had become particularly associated with Newton by 1714.[55] Given the connection between experimentation and Newton, Saulmon's use of experiments to confirm his understanding of Descartes's vortices empirically was especially unusual. In Saulmon's writing we can see a strong desire to connect experiments with natural phenomena. He reasons inductively that if the fluids in his

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[53] Saulmon was an eighteenth-century French scientist and mathematician. Though Saulmon's work appears in the Academy's *Histoires*, he does not appear to have published a great deal. The extant publications, including those cited here, appear with only his last name. Shank notes that Saulmon entered the Academy with the low rank of an *élève* in 1707 (see Shank, *The Newton Wars*, 154). Other details of his life, including his birth and death dates, are unknown.

[54] Saulmon, "Expériences sur des corps plongez dans un tourbillon," *Histoires de l'Académie Royale des Sciences-Mémoires* (1714): 381-94.

[55] Shank, *The Newton Wars*, 154-156.

experiments behave in a certain way, then all fluids "in nature" must also behave this way. For example, the study opens,

> The circular movement of fluids produces considerable effects in nature, such as gravity [*pesanteur*] and the regular orbits of the planets. Experiments are among the most certain means of recognizing the cause. I have made a few of them [experiments], as I recount in this report.[56]

Recall that Cartesian physics posited that the planets were suspended in a kind of celestial fluid. Vortices made from this fluid were thought to govern planetary motion. For Saulmon, the behaviour of the fluids in his bucket was evidence that fluids in space behaved the same way. Rameau engages in a similar inductive practice in his own experiments. For Rameau, the resonance of tongs serves as valid musical evidence that the pitches of the *corps sonore* are perceivable in any vibrating body. He reasons that the tongs resonate this way because all vibrating bodies do. Rameau shares Saulmon's view that phenomena that take place "in nature" can also be replicated in a controlled, small-scale experiments and manifest the same effects.

In a review of Saulmon's work, however, Fontenelle was hesitant to accept Saulmon's conclusions because of the lack of control over natural forces that he believed made all experiments inherently problematic. Fontenelle seems sceptical from the start;

> Nothing would be more glorious for physics aided in geometry than to have discovered how the known laws of mechanics as we know them produce celestial movement, and how there is every appearance that it is this movement that controls the general reason for gravity; at the same time we would have the explanation for a phenomenon so common, yet so complex. But because the *original* reasons [for these motions] are normally too hidden from us, we must attempt to reappraise the issue little by little through experiment, and construct for

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[56] **"**Le mouvement circulaire des fluïdes produit des effects considérables en la nature, tels que sont la pesanteur et les révolutions périodiques des Planetes. Les expériences sont un moyen des plus sürs pour en reconnoiter la cause. J'en ai fait quelques-unes, que je rapporte en ce Mémoire." Saulmon, "Experiences sur des corps plongez dans un tourbillon," 273.

> ourselves man-made heavens, specifically with fluids in circular motion that will propel bodies, models of the planets, or weighty bodies.[57]

But Fontenelle doubts that we can manufacture perfect models of these artificial heavens. Later on he adds that some of Saulmon's results actually disprove his own hypothesis, but that Saulmon ought not to despair; sometimes that which seems like an obstacle can eventually stimulate research.[58]

Saulmon's experiments were predicated on the idea of creating liquid vortices in a bucket or a glass vase and then observing the behaviour of solids moving in the fluid. His experiments resemble Mairan's in their design. Rather than presenting initial propositions and experiments, Saulmon incorporates his experiments and their results into the main body of his text.[59] Like Mairan, years later, Saulmon does not instruct the reader how to recreate the experiments. He simply relays what he has already done and observed.

In terms of materials, however, Saulmon's experiments are similar to Newton's and to Rameau's. In order to recreate them, the reader would only need a bucket, a moderate amount of fluid (enough to swirl into a vortex), and assorted objects to drop into the bucket. During his experiments, Saulmon dropped objects like small pieces of lead and tin, as well as small wooden boxes into the vortex to see if they would float and to observe their rate of movement. Any enthusiastic reader who wished to participate

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[57] "Rien ne seroit plus glorieux à la Phisique secouruë de la Geometrie, que d'avoir découvert comment les loix de la Méchanique que nous connoissons produisent les mouvements celestes et comme il y a toute l'apparence possible que c'est à ces mouvements que tient la cause generale de la pesanteur, on auroit en même temps l'explication d'un phénomene si commun et si difficile. Mais parce que les raisons *à priori* nous sont ordinairement trop caches, il faut tâcher d'y remonter peu à peu par des experiences, et nous faire des Cieux artificiels, c'est-à-dire, des fluides mûs circulairement, qui emporteront des corps, images des Planetes, ou des corps pesants." Bernard le Bovier de Fontenelle, "Sur le mouvement des solides dans un tourbillon fluide," *Histoires de l'Académie Royale des Sciences-Histoires* (1714), 102.

[58] Ibid., 106.

[59] The limited space available for reports issued in the *Histoires* might have necessitated such a design.

could have easily repeated the experiments. Even though the experiments were designed to explore a Cartesian principle such as the vortex, his recourse to experimentation demonstrates the spirit of Newtonianism in his work.

After Newton's *Opticks* was published in Latin and reviewed by the Academy, Étienne François Geoffroy was one of the first Frenchmen to become interested in the "attractionist" aspect of Newtonian science. In 1718 he appeared at the Academy's spring assembly to demonstrate his work on attraction among chemical compounds.[60] He created a table of chemical relationships (shown below in Plate 1) that was published in the *Histoires de l'Académie Royale des Sciences* in 1718. Not unlike the modern Periodic Table of the Elements, Geoffroy's table showed different affinities of substances toward one another. The symbols in the top row represent substances commonly used in chemistry. Each column lists additional substances in order of their degree of affinity to the substance in the top row. For instance, Geoffroy explains, the *esprits acides* (acids) in the top left position have the greatest affinity with *sel alcali fixe* (fixed alkali salt), which takes the second space in the column. The other three substances in the column, including *sel alcali volatil* (volatile alkali salt), *Terre absorbante* (absorbent earth materials such as soil, dust, or clay), and *substances metalliques* (metallic substances), still share an affinity with *esprits acides* but less so than the *sel alcali fixe* that appears closer to the top of the column. Several substances appear more than once on the table as they share affinities with multiple other substances. The other columns follow the same logic and demonstrate

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[60] Etienne François Geoffroy, "Tables des différents rapports observé en chimie entre différentes substances," *Histoires de l'Académie Royale des Sciences* (1718): 202-12.

the degrees of *rapport* between these substances commonly employed in the study of chemistry.

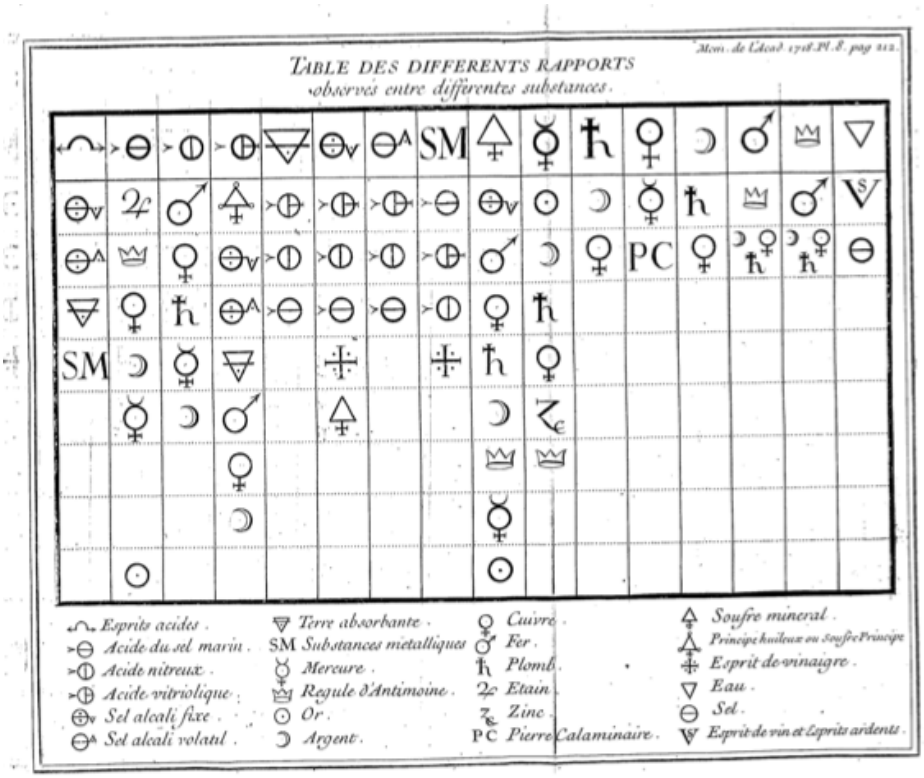

Plate 1. Geoffroy's *Table des Differents Rapports*, 1718.

Geoffroy emphasized that it was possible to observe the different degrees of relationship (*rapport*) between substances, a claim that signalled the importance of empirical observation in his work. The link between his work and Newtonian attraction was perceptible to readers like Fontenelle, who disliked Geoffroy's use of attraction in his work as a chemist.[61] He found Geoffroy's work to be more descriptive than analytical, saying:

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[61] Shank, *The Newton Wars*, 117.

> The more chemistry is perfected, so too will be M. Geoffroy's table, both for the greater quantity of substances that it embraces, and for the ordering and accuracy of the relationships. If physics is not capable of the certainty of mathematics, it can at least not do better than to imitate its order.[62]

Fontenelle maintained that mathematics was still more certain than either physics or chemistry.

Geoffroy's Newtonianism is primarily seen in his devotion to observation as the primary way to understand the attraction between chemical substances. Because of his support of Newton's *Opticks*,[63] characteristics of his work became more strongly associated with French Newtonianism. Additionally, we can note the discomfort Fontenelle expressed in his review of Geoffroy's work as a sign that it contradicted the prevailing Cartesian epistemology.

Geoffroy's analysis of *rapport* between substances is somewhat similar to Rameau's discussion of *rapport* between modes, or the degrees of relationship between keys. Rameau's characterization of modal *rapport* in *Génération harmonique* contrasts with his earlier treatises. Here, the degree of *rapport* comes from the mode's origin in the geometric progression. Recall that the geometric progression is any series of numbers that share a common multiple, such as the geometric fifth progression, 1 : 3 : 9 : 27. Rameau used this progression as the rational basis of a series of musical fifths that serves as the origin of a mode. In this case, the mode was defined by the fifths above and below

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[62] "Plus la Chimie se perfectionnera, plus la Table de M. Geoffroy se perfectionnera aussi, soit par une plus grande quantité de substances qu'elle renfermera, soit par l'arrangement et l'exactitude des rapports. Si la Phisique ne sçauroit arriver à la certitude des Mathematiques, du moins ne peut-elle mieux faire que d'en imiter l'ordre." Fontenelle, "Sur les epreuves de l'eau de vie et de l'esprit de vin," *Histoires de l'Académie Royale de Sciences-Histoires* (1718), 37. See Shank, *The Newton Wars*, 118 for more on Fontenelle's treatment of Geoffroy.

[63] Shank, *The Newton Wars*, 115-116. Shank notes that Geoffroy was one of the first to translate *Opticks* into French (though his translation was never published) and that he presented *Opticks* to the Academy in 1706, just before the work was translated into Latin and published in France.

the tonic, or the dominant and subdominant respectively. If the tonic C is considered the middle term of the progression 1: 3 : 9, then we can imagine F : C : G corresponding to the 1:3:9 progression. Modes separated by only one term, such as F and C, had a high degree of *rapport*.[64] Rameau represents these modal relationships in tables found in both *Nouveau système* and *Génération harmonique* (shown below in Plate 2).[65]

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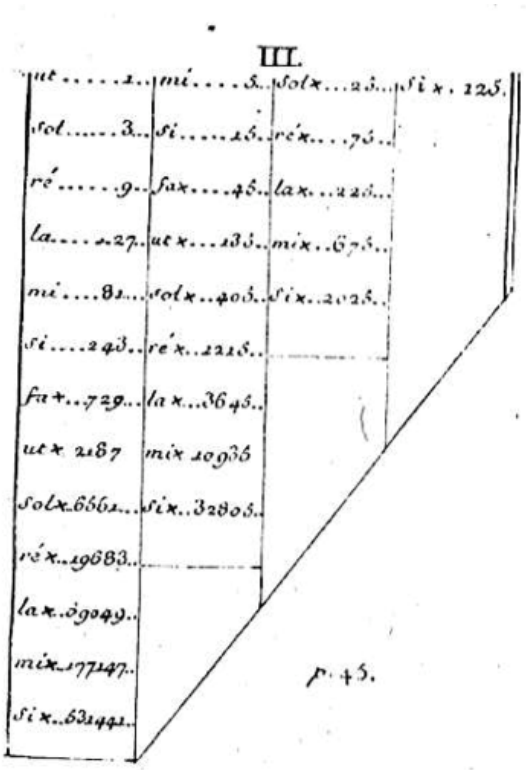
[64] Rameau, *Génération harmonique*, 139-42; Hayes, "Rameau's Theory of Harmonic Generation," 164.

[65] In Plate 2 I have reproduced Rameau's original table that includes solfege syllables. In the second plate I have recreated the table for ease of reading it, this time with letter names instead of solfege.



C 1	E 5	G# 25	B# 125
G 3	B 15	D# 75	
D 9	F# 45	A# 225	
A 27	C# 135	E# 675	
E 81	G#. 405	B# 2025	
B 243	D#. . . . 1216		
F#. 729	A#. . . . 3645		
C#. 2187	E#. . . . 10935		
G#. . . . 6662	B#. . . . 32805		
D#. . . . 19683			
A#. . . . 59049			
E#. . . 177147			
B#. . 5331441			

Plate 2. Original and reproduction of Rameau's Table of Geometric Progression from *Génération harmonique* p. 45

Rameau organizes his table vertically according to the geometric triple progression, with perfect fifths descending from C, E, and G# in the top row. Like the materials of Geoffroy's table, modes with a high degree of *rapport* appear within the same column on Rameau's table. Just as Geoffroy theorizes that substances that share common elements have an affinity for one another, Rameau explains that modes that share common tones have a high degree of rapport:

> The close relationship we have just noticed is still based on their having two common terms, 3 and 9, either in 1 : 3 : 9, or in 3 : 9 : 27. From which it follows that these two terms, representing fundamental sounds, the more common tones modes have between them the more related they are.[66]

This same table also horizontally displays the geometric quintuple progression in terms of major thirds. Just as the terms 1 : 3 : 9 represented a series of fifths, the terms 1 : 5 : 25 represented a series of major thirds corresponding to C, E, and G#. The vertical lines separating each column emphasize that the modes in the same horizontal row do not share as many common tones as those in the same column. All this is not to suggest that Rameau's concept of modal *rapport*, or his tables that represented it, are based on Geoffroy's table or his theory of chemical *rapport*. Yet we can see Rameau's use of the term "*rapport*" and the table as indicative of his general interest in scientific explanations of musical phenomena.

Unlike Saulmon and Geoffroy, who employed experimental science and attraction in their work, Dutch philosopher Willem s'-Gravesande (1688-1742) specifically intended for his work to spread Newtonian science on the Continent. s'-Gravesande was

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[66] "Ce rapport que nous venons de remarquer entre deux Modes, se fonde encore sur ce qu'ils ont deux termes communs, 3 et 9 dans 1. 3. 9, ou dans 3 . 9 . 27; d'où il suit que ces termes représentant des Sons fondamentaux, plus les Modes auront de Sons communs entr'eux, plus ils seront relatifs." Ibid.

among the first "self-proclaimed" Newtonians on the continent.[67] Voltaire also met s'-Gravesande and attended his public lectures during his trip to Holland in the 1730s.[68] His *Mathematical Elements of Natural Philosophy Confirmed by Experiments, or, An Introduction to Sir Isaac Newton's Philosophy* (1721) was originally written in Latin. Desaguliers, a French-born philosopher who grew up in England, then translated it into English.[69] French Newtonianism was strongly connected to the work of Dutch authors like s'-Gravesande because of Voltaire's interest in issues of specifically Anglo-Dutch Newtonianism.[70] Though Anglo-Dutch Newtonianism is typically associated with gravitational attraction, s'-Gravesande was particularly interested in Newton's work on light and on bodies in motion on a smaller scale, in addition to celestial motion.

s'-Gravesande's title, *Mathematical Elements of Natural Philosophy Confirmed by Experiments, or, An Introduction to Sir Isaac Newton's Philosophy*, gives a strong impression of the connection between Newtonianism and experimental science. He meant to confirm each of his arguments with experiments in order to provide a visual and experiential aid to mathematical concepts. Though his audience consisted of his own

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[67] Shank, *The Newton Wars*, 122-123, also 137.

[68] Ibid., 259.

[69] I will refer to Desaguliers's English translation: William-James s'-Gravesande, *Mathematical Elements of Natural Philosophy Confirmed by Experiments, or An Introduction to Sir Isaac Newton's Philosophy*, 2nd ed., 2 vols., trans. J. T. Desaguliers, (London: J. Senex, Fleet-street, W. Innys and R. Manby in St. Paul's Church-yard, and T. Longman in Pater-Noster-Row, 1731). The original Latin title is *Physices elementa mathematica, experimentis confirmata, sive introduction ad philosophiam Newtonianam.*

[70] Girdlestone states that Rameau traveled to Holland around 1730-1731. Girdlestone does not provide any further information about Rameau's visit (and no other documents about it may exist), however, it is worth noting that he traveled to Holland during this time when Newtonianism would have been especially popular there, even more so that it was in France. See Girdlestone, *Jean-Philippe Rameau*, 475.

university students, s'-Gravesande felt that his mathematical illustrations alone were too abstract for his readers to understand without a physical demonstration.

Experiments feature prominently in s'-Gravesande's treatise, yet they are not the central focus of his work as they are in *Opticks*. Before embarking on the experiments, s'-Gravesande gives ample definitions and discussion. Many of the experiments in Book I deal with dropping small amounts of water onto a glass surface from various heights and positioning the glass at different angles in order to observe the shape and movement of the water droplets.[71] He believed that these experiments demonstrated that drops of liquid that fall near each other attract one another if they so much as barely touch.

s'-Gravesande's and Rameau's experiments share some characteristics. For s'-Gravesande, the experiments have an understandably specific purpose – to demonstrate the validity of Newtonian physics to his students. Rameau's experiments have a similar purpose, as he seeks to confirm the natural status of the *corps sonore*. s'-Gravesande's experiments are also like Rameau's in their style, in that they are written as a set of instructions for a reader to recreate. However, Rameau uses his experiments in a tactical way that s'-Gravesande does not. For s'-Gravesande, the significance of his experiments is simply that they validate his otherwise abstract claims. For Rameau, experiments seem to have been intended to provide the imprimatur of scientific work, and prove that he possesses the required expertise. s'-Gravesande already enjoyed status as a scientist and thinker in the Netherlands before publishing his account of Newton's works. Rameau, on

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[71] s'-Gravesande, *Mathematical Elements of Natural Philosophy Confirmed by Experiments*, Book 1, 12-13.

the other hand, likely saw science as a way to enhance his reputation, in addition to providing validation for his harmonic theory.

In 1735, s'-Gravesande published another version of the same material, entitled *Explanation of the Newtonian Philosophy in Lectures read to the Youth of the University of Leyden*. Like the original treatise, the later one was translated from Latin into English. Yet unlike his first treatise, s'-Gravesande opted to omit the actual experiments from the second work in order to save space, for he notes where they would have fit in his text by marking "EXP" in parenthesis throughout).

s'-Gravesande makes several significant statements in this treatise that have implications for Newtonianism in general and especially for Rameau. He states that he knows his work does not follow Newton completely, but he still calls it Newtonian because it is based on Newtonian ideas. He writes,

> Even for another reason the subject of this book is fitly called the Newtonian Philosophy; for that is deservedly called Newtonian Philosophy, wherein Conclusions are deduced from Phenomena, and Hypotheses rejected; since no Body before Sir Isaac Newton chastely followed this method, far from proposing to follow it in all things.[72]

s'-Gravesande believes his own work is Newtonian because it is based on Newton's ideas and, more importantly, because it is based on empirical observation. His idea that "Newtonian" texts can be considered as such even with a tenuous connection to Newton's ideas has implications for the likely reception of *Génération harmonique*. Rameau's recourse to empiricism in 1737 was likely considered Newtonian, if only by some. Rameau's writing has other connections to French Newtonianism, as I will explore

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[72] Willem Jacob s'-Gravesande, *Explanation of the Newtonian Philosophy in Lectures read to the Youth of the University of Leyden*, 2 vols., (London: Printed for W. Innys and R. Manby, Printers to the *Royal Society* at the West End of St. Paul's, 1735), A3-A4.

in chapter 4, in his use of the language of gravitational attraction. However, s'-Gravesande's explanation of the importance of observable phenomena for Newtonianism shows that Rameau's use of experiments and his new reliance on empiricism are the single most important aspects of his Newtonianism in *Génération harmonique.*

Algarotti's *Newtonianisme pour les dames* (1738, translated to English in 1739), briefly introduced in Chapter 2, serves as a final example of the Newtonian culture in which *Génération harmonique* was conceived. Algarotti includes experiments that employ the reader's sensory organs in ways reminiscent of Rameau's experiments. Algarotti's work is structured as a series of dialogues between a man, presumably himself, and a wealthy, fairly well educated woman. The dialogues cover a wide range of Newtonian topics, notably the correlation between sound and light, as well as physical demonstrations of various Newtonian concepts. The unusually large number of printings and translations of this work point to the increased public appetite for accessible scientific literature, as Sarah Hutton has pointed out.[73] Hutton also stresses that this work is not necessarily intended only for women readers, but that "*dames*" in this context implied anyone who lacked scientific expertise, thus connecting it to other Newtonian writings like s'-Gravesande's writing "for the Youth."[74]

In contrast to the papers included in the Academy's *Histoires*, Algarotti's style of discourse is much less formal, and his book reads as a narrative in which two people discuss the benefits of different philosophical and scientific methods. While he does not follow the same proposition-experiment format, empirical observation does play a role in

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[73] Hutton, "Women, Science, and Newtonianism: Emilie du Châtelet versus Francesco Algarotti," 186.

[74] Ibid.

Algarotti's explanations of Newtonian science. He considers the event of pricking a finger with a needle to demonstrate that the pain does not exist within the needle itself but in one's reaction; by analogy, he explains that light does not exist within objects themselves but that one can cast light on them from the outside**.** [75] Later in the text, while discussing a different principle of light, the narrator does not feel that the lady understands the thrust of his argument. In order to clarify his point, he suggests the experiment from *Opticks* in which Newton pressed his eye with his finger in order to see the colours present when the eye is closed.[76] He requests that the lady press the corner of her eye with her finger and then look away from that corner to observe "a round flame of a reddish color."[77] Algarotti does not cite or refer to Newton as he explains things, yet all the dialogues serve to elucidate Newton's propositions. Like Rameau, Algarotti used accessible language and his readers' sensory organs to explain the principles of Newtonian science.

Reviews of and Reactions to Newtonianism in *Génération harmonique*

Contemporary reviews of *Génération harmonique* from the 1730s consistently connected Rameau's work with Newton, or with Mairan, and experimental science in general. Many of the reviewers to be discussed below wrote favourably of Rameau's achievements in

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[75] Francesco Algarotti, *Sir Isaac Newton's Philosophy, Explained for the Use of the Ladies, in Six Dialogues on Light and Colours, From the Italian of Sig. Algarotti*, 2 vols., trans. Elizabeth Carter, (London: E. Cave, at St. John's-Gate, 1739) vol. 1, 83-84. This edition is based on the original Italian text: *Il Newtonianismo per la dame ovvero Dialoghi sopra la luce, i colori, e l'attrazione* (Napoli, 1737). A French translation of the original text was first published in 1738. I will refer to the English one throughout.

[76] Newton explains this experiment in *Opticks*, 347.

[77] Algarotti, *Sir Isaac Newton's Philosophy*, 85.

music theory and downplayed the errors in his science. Here I discuss three of the reviews of *Génération harmonique* in order to provide a survey of critical reactions. Multiple reviewers cited errors in his mathematical or scientific claims. Others readily connected Rameau's experiments with Newton, only referring incidentally to Mairan. These reviews help us understand how his work was received in the context of the scientific trends of the day.

One especially positive review in *Le Pour et contre* from 1737 commended Rameau for being the first music theorist to truly study the foundation and principles of music.[78] After summarizing the work, the author shows an awareness that Rameau framed his music theory with his reputation in mind. The reviewer writes, "In the wake of these observations that are in the domain of everyone, we witness the musician following the philosopher."[79] In other words, mathematics (such as they are) and the relevant aspects of temperament, ratios, and experiments, come first, followed by the more practical aspects of his theory; first he is a philosophe, then a musician. Rameau was likely pleased to see his work favourably compared to the work of other intellectuals. Though he was likely unhappy with the reviewer's characterization of his work as unsystematic, he surely appreciated the rest of the assessment:

> Of everything that I have just summarized, I believe the work of M. Rameau will be judged not so much as a system but as a perceptible and tangible demonstration of music in its original sense and all its attendant effects. Since the principle on

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[78] *Le Pour et Contre* 179 (1737), 25-48; reproduced in volume 6 of *The Complete Theoretical Writings of Jean-Philippe Rameau (1683-1764)*, ed. Erwin R. Jacobi, 6 vols. (American Institute of Musicology, 1967-72), 118-125; hereafter cited as *CTW*.

[79] "A la suite de ces Observations qui sont à portée de tout le monde, nous voions le Musicien suivre le Philosophe." Ibid., 42; *CTW*, vol. 6, 123.

> which it is based is given to us by nature, as we have seen, and that everything is produced in it harmonically, arithmetically, and geometrically.[80]

The review continues:

> This truth was always there, but it had to see the light of day to be discovered; it took a great musician but, at the same time, one who was able to become capable a physicist and geometrician skilled in this area to gather together from a single perspective with the ancients, whether musicians, or physicists, or geometricians left us of their various researches in the end…That would be sufficient to pay him a testimonial, but it could never be complete, because his skilled and attractive practice [as a composer]competes [against his other achievements] presently, and will add still more [to his fame].[81]

This author sees Rameau as the long-awaited *musician-savante* whose correctly blended knowledge of music, physics, and geometry will finally unite these disciplines. Rameau was undoubtedly pleased with a heroic portrayal of his work, similar to the way others like Voltaire and Algarotti described Newton's work.

Another review, from *Observations sur les ecrits modernes* in 1737, criticizes Rameau's motives.[82] This author is not convinced that Rameau's theory is based on Mairan's hypothesis. He first cites Mairan's hypothesis that air is made of particles of varying elasticity, capable of vibrating at varying frequencies that correspond to vibrating bodies (*corps sonores*), and that we perceive these vibrations through similar vibrations

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[80] "De tout ce que je viens d'extraire, je crois que l'on jugera l'Ouvrage de M. Rameau, moins comme un Sistême, que comme une demonstration sensible et palpable de la Musique prise dans son origine et suivie dans tous ses effets; puisque le principe sur lequel il se fonde nous est donné, comme nous l'avons dit, par la Nature, et que tout en est produit *Harmoniquement*, *Arithmétiquement*, et *Géométriquement*." Ibid., 47; *CTW*, vol. 6, 125.

[81] "Cette vérité existoit, mais il falloit être né pour la découvrir; il falloit un homme grand Musician, mais tout à la fois capable de devenir Physicien et Géometre habile en cette partie pour rassembler sous un même point de vûe ce que les Anciens, ou Musiciens, ou Phisiciens, ou Géometres, nous ont laissé à dernier dans leurs différentes recherches…Ç'en seroit assez pour faire son éloge, mais il ne sauroit être complet, parce que sa pratique savant et agréable y concourt actuellement, et y ajoûtera toujours." Ibid., 47; *CTW*, vol. 6, 125.

[82] "Lettre de M. *** à M. l'Abbé D. F.; Sur le nouveau livre de M. Rameau," *Observations sur les Ecrits Modernes* 10, 68-72; *CTW*, vol. 6, 127-128.

inside our ears. He also cites Mairan's reference to Rameau, the "celebrated musician" who would test this theory in his own treatise on music. Then he writes,

> That is precisely, Monsieur, what I find no trace of in M. Rameau's treatise on *Génération harmonique*. I say, further, that is not what I seek in it, and even less, nothing seems more insignificant to the principles, to the propositions, [or] to the experiments M. Rameau offers, than a hypothesis of Mairan.[83]

This reviewer believes Rameau's work bears no significant resemblance to Mairan's. He argues further that he does not see how Mairan's work relates to the fundamental bass or why Rameau would have used it to somehow prove the importance of the fundamental bass.

Instead, this reviewer says Rameau may have simply tried to capitalize on the fact that Mairan was interested in his work, as he undoubtedly found Mairan's interest complimentary, and thought he could win Mairan's favour through flattery:

> It is easy to grasp that M. Rameau willingly appropriated the hypothesis, no doubt believing that it was to honour his [presumably Mairan's] work with a new title, or with a view, perhaps, of obtaining approval, as if the celebrated Academician might have had some interest to encourage it.[84]

According to this reviewer, Rameau's work did not relate closely to Mairan's, but Rameau saw in Mairan's work a means of obtaining Academy approval. The reviewer does not think that Rameau's plan to exploit Mairan was successful:

> But if M. Rameau had this goal, it is that he wished to delude himself. M. Mairan's modesty renders him impervious to the acts through which one might wish to seduce him, and we see that if M. Rameau marries his principles and

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[83] "Voila précisement, Monsieur, ce que je ne trouve point dans le Traité de la *Génération harmonique* de M. Rameau: Je dis plus; c'est ce que je n'y cherche pas, et d'autant moins, que rien ne me paroît plus indifferent aux principes, aux propositions, aux expériences, que donne M. Rameau, qu'une hypothese de [Mairan]." Ibid., 69-70; *CTW*, vol. 6, 127.

[84] "[Il] est aisé de comprendre que M. Rameau s'est volontiers approprié l'hypothése, sentant bien que c'étoit honorer son Ouvrage d'un titre, ou dans la vûe peut-être d'obtenir un suffrage, où le célébre Académicien auroit eu quelque interêt à la flatter." Ibid., 71-72 ; *CTW* vol. 6, 128.

> experiments to M. Mairan's hypothesis, Mairan will evade him, and assign the honour of the original ideas of this hypothesis to M. Newton who, in effect, [Mairan] only imitated.[85]

This reviewer thought that if Rameau intended to use Mairan's status to his advantage, then he would likely be disappointed.

In another 1737 review from *Observations sur les ecrits modernes*,[86] the reviewer writes that despite Rameau's achievements, "there are still veils that we must remove from the mysteries of harmonic science."[87] He also makes a direct connection between Rameau's work and Newton's before mentioning Mairan as Rameau's source. After quoting Rameau's hypothesis (taken from Mairan), he writes,

> This ingenious idea is derived from Newton's system on light by M. de Mairan, as M. de Fontenelle reports in the *Mémoires de l'Académie des Sciences* (1720, p. 11) and as M. de Mairan himself recognized in his learned dissertation which he read a few months ago at the *Académie des Sciences*, for which an extract of may be found in *Le Mercure* of last June.[88]

From the comments in these reviews, we can see that readers who were familiar with Newton's work easily connected Rameau's work with his and with Mairan's (however disparagingly).

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[85] "Mais si M. Rameau a eu cet objet, c'est qu'il a voulu se faire illusion. La modestie de M. de Mairan le rend inaccessible aux traits par lequels on voudtroit le séduire, et nous voyons que si M. Rameau marie ses principes et ses experiences à l'hypothese de M. de Mairan, M. de Mairan lui échape, et renvoye l'honneur des premieres idées de cette hypothese à M. de Newton, qu'en effet il n'a qu'imité." Ibid., 72 ; *CTW* vol. 6, 128.

[86] "Lettre 139," *Observations sur les Ecrits Modernes* (1737), 73-86; *CTW* vol. 6, 129-133.

[87] "Il y a encore bien des voiles, qui nous dérobent les mysteres de la science harmonique." Ibid., 74; *CTW* vol. 6, 129.

[88] "Cette idée ingenieuse est imitée du systême de M. Newton sur la Lumiere, par M. de Mairan, comme M. de Fontenelle le rapporte dans les Mémoires de l'Académie des Sciences (année 1720, p. 11) et comme le reconnoît M. de Mairan lui-même dans la sçavante Dissertation qu;il lût il y a quelques mois à l'Académie des Sciences, et dont l'Extrait se trouve dans le Mercure du mois de Juin dernier." Ibid., 77; *CTW* vol. 6, 130.

In this second review in *Observations*, the author takes aim at Rameau's science. The reviewer finds the experiments to be unhelpful, particularly the one with tongs, discussed earlier, as well as an experiment performed with the trumpet.[89] He writes,

> The trumpet experiment,[…]explained by Father Mersenne, and reported by our Author [Rameau], is still very curious and he draws from it conclusions that are fairly useless for the art of music, but which could enrich physics.[90]

For this reviewer (who, from his comments, we can guess was not a scientific expert) all the physics in Rameau's explanations is not ultimately useful for understanding art. He found the parts that dealt with music theory digestible because they did not involve physics. Further, he writes, the physics involved is difficult to understand:

> It is necessary to study M. Rameau's book. But how many people are in a position to study this book? I might advance here that a mere geometrician or a mere musician will not understand it at all. One must at once be a speculative and practical musician, that is to say well versed both in science and in harmonic routine….To console oneself for not understanding the work in several spots at all, it would be nice to be able to suspect the author himself to be sometimes in a similar circumstance."[91]

He writes that using physics to understand music is like giving a dance instructor an anatomy book in order to teach dance. He further argues that, "For all the arts that depend on genius and taste, one usually believes that the elements and some simple and practical

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[89] Ibid., 80-81; *CTW* vol. 6, 131.

[90] "L'expérience de la trompette, […] expliquée par le Pere Mersenne, et raportée par notre Auteur, est encore très-curieuse, et il en tire des conclusions assez inutiles pour l'art de la Musique, mais dont la Physique peut s'enrichir." Ibid., 80-81; *CTW* vol. 6, 131.

[91] "Il faut étudier le Livre de M. R. Mais combien de personnes sont en état de l'étudier ce Livre? Je puis avancer ici qu'un simple Géometre, ou un simple Musicien ne l'entendront point. Il faut être tout-à-la-fois Musicien de spéculation et de pratique, c'est-à-dire, versé et dans la Science et dans la Routine harmonique. […] Pour se consolation de ne point entendre l'Ouvrage en plusieurs endroits, qu'il seroit doux de pouvoir soupçonner l'Auteur de ne s'être pas quelquefois entendu lui-même." Ibid., 82; *CTW* vol. 6, 132.

rules can suffice."[92] In his final comments the author emphasizes that science is not the tool that artists need: "Genius alone can inspire the new: this genius that never produces the sterile copier, the rampant imitator."[93]

> This reviewer especially criticized Rameau's concept of the fundamental bass:
>
> You see that M. Rameau does nothing more than hint [at the fundamental bass], he is still a little in the dark. He gropes his way; he gets close, but he does not yet grasp. It is not the same, to be sure, to treat, he only believes it.[94]

He goes on to say that for all the physics and science in *Génération harmonique*, Rameau's concepts are often metaphysical, especially the fundamental bass. Despite the problematic consequences, he says, Rameau clings to this concept. He writes, "The Author [Rameau] draws from this fecund principle a great number of consequences; I would be willing to go deeper with him, if it were that easy, and if I were of the humour to give myself a migraine."[95] Despite Rameau's attempts to rationally and empirically prove the natural origin of the fundamental bass, this author finds his work to be overly complicated and unnecessarily scientific. The scientific aspects associated with Newtonianism that Rameau added to *Génération harmonique* did little to convince this reviewer.

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[92] "Pour tous les arts qui dependent du génie et du gout, on croit communément que les élémens et quelque régles simples et pratiques peuvent suffire." Ibid., 85; *CTW* vol. 6, 133.

[93] "C'est le génie seul qui inspire le neuf, ce génie, que ne fit jamais le stérile copiste, ni le rampant imitateur." Ibid., 85; *CTW* vol. 6, 133.

[94] "Vous voyez que M. R. ne fait encore qu'*entrevoir*, il est encore un peu dans l'obscurité. Il marche à tâtons; il *touche de près*, mais il ne tient pas encore. Il n'est pas même bien sûr de *toucher*, il le *croit* seulement." Ibid., 75; CTW vol. 6, 129.

[95] "L'Auteur tire de ce principe fécond un grand nombre de conséquences, que j'approfondirois avec lui, si cela étoit facile, et si j'étois d'humeur de me donner la micraine." Ibid., 83; *CTW* vol. 6, 132.

In 1737 Mairan provided an impassioned response to the first 1737 review in *Observations* (see Footnote 82). He says that the author wrongly assumed that Mairan envisioned his hypothesis regarding the propagation of sound as the seed for Rameau's *Génération harmonique*. He seems personally offended by the idea that he would have let Rameau imitate him because he (Mairan) craved some kind of academic flattery. Nor did he, as the review suggested, refrain from explaining his own theory in detail because he expected Rameau to do it for him. Mairan states that Rameau took his advice and then created his own original work. True to his rather messy mix of philosophical orientations, Mairan further disapproved of the reviewer's comment, quoted above, that his work imitated Newton's. He believed he deserved more credit than simply being an imitator, and accuses the reviewer of not having properly read the texts he reviewed:

> If this author nevertheless had not understood either my hypothesis, or its use as Rameau had wanted to do with it, if he misread the Extract of my *Discours* in *Le Mercure*, and M. Rameau's design in his book, it would not require, it seems, for a complete response to his letter, and for total clarity to direct the reader to return to *Le Mercure* and M. Rameau's book.[96]

While maintaining an air of courtesy, Mairan suggests that the reviewer's criticisms were caused by a misunderstanding and inadequate reading of the texts, rather than by deficiencies in Rameau's theories.

Regarding his relationship with the music theorist, Mairan clarified that he only spoke of Rameau in relation to his work on musical experience. In addition, he reminded his readers that Rameau's work with him otherwise had met with widespread approval by

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[96] "Si cet Auteur cependant n'avoit entendu ni mon Hypothese, ni l'usage qu'en a voulu faire M. R. , s'il avoir mal lû l'Extrait de mon Discours dans le Mercure, et le plan de M. R. dans son Livre, il ne faudroit, ce semble, pour toute réponse à sa Lettre, et pour tout éclaircissement, que renvoyer le Lectuer au Mercure, et au Livre de M. R." D'Ortous de Mairan, "Eclarcissement de M. de Mairan sur la Lettre anonyme inserée dans la 138^{e} Lettre des *Observations*, ci dessus, page 68," *Observations sur les Ecrits Modernes* (1737), 351; *CTW* vol. 6, 134.

the Academy as a method of understanding music through the physics of sound. He argues,

> Finally, one must take care, that the only connection that I imagine between Rameau's treatise and my hypothesis, resides in the experiment that serves as the basis of his theory that is, in my view, as clearly explained by this hypothesis as it is inexplicable through any other system.[97]

He argues that Rameau adopted his hypothesis only because it explained the principle behind the fundamental bass. From Mairan's comments we can see that he did not intend to collaborate with Rameau in order to bolster Rameau's reputation, or for any other reason for that matter.

Conclusion

From the above discussion, we can see that the experiments in *Génération harmonique* shared some features with Newtonian documents written between 1700 and 1740. Like many of his contemporaries, Rameau sought to create experiments that were accessible to lay people, and that involved household (and some musical) materials. I have attempted to show that, even if Rameau did not self-consciously understand his work as Newtonian, his use of experiments was frequently evaluated in this light. On one hand, the use of elements of Mairan's and Newton's works suggests that he meant both to validate his theory and to establish his public reputation as a scientific thinker. On the other hand, the scientific characteristics of his work might profitably be understood to contribute to French Newtonianism, if only in a limited way.

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[97] "Enfin, il faut prendre garde, que toute la liaison que j'ai suppose entre le Traité de M. R. et mon Hypothese, ne consiste qu'en ce que l'expérience qui fait la base de sa Théorie est, à mon avis, aussi clairement expliquée par cette Hypothese, qu'inexplicable par tout autre Systême." Ibid., 353-54; *CTW* vol. 6, 135.

Rameau's relationship with Mairan is perhaps his most significant relationship to any Academy member during the 1720s and '30s. His later acquaintance with d'Alembert certainly impacted his legacy, and his relationship with the Encyclopedists figured prominently at the end of his career. In the 1730s, however, Mairan supplanted Castel as Rameau's primary source of scientific approval.

Rameau's association with Mairan has implications for our broader understanding how *Génération harmonique* fits into French Newtonianism. Even if Rameau did not truly attempt to take advantage of their relationship, some of his reviewers were able to make a connection between his work, Mairan, and Newton. Rameau, however, never responded to this interesting circumstance.

If Rameau did intend to involve Mairan in his work for the sake of his image, then he did an especially good job. He managed to secure the support of an Academician who was fundamentally a Cartesian, and therefore still a conventional member of the academic community in the 1730s, but who was also interested in Newton. It is significant that none of the reviewers cited Rameau's relationship to Mairan as an example of his interest in Cartesian physics or any other scientific or philosophical method. They simply connected him to Newton.

Rameau's use of Mairan's materials and Mairan's citation of his work should have provided him with a win-win situation. He dedicated *Génération harmonique* to the Academy and tried to use Mairan's work to appeal to its members in the early part of the text. According to Hayes, this was Rameau's final attempt of many to enter the

Academy.[98] From Rameau's perspective, the process of giving his harmonic theory a Newtonian image (however unknowingly) either would have earned him public prestige for his use of trendy science, or it might have resulted in Academy membership. In either case, his public visibility as an intellectual would have increased. However, as we will see in Chapter 4, neither outcome in the scientific arena obtained.

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[98] Hayes, "Rameau's Theory of Harmonic Generation," 284-85. However, as we will see in Chapter 5, Rameau wrote more treatises after *Génération harmonique* in an effort to win the Academy's favor.

Chapter 4: Rameau, Voltaire, and Castel

This chapter examines the second major aspect of Newtonianism in the latter part of Rameau's *Génération harmonique*, as well as the social implications of Rameau's scientific orientation as perceived by his critics. In contrast to Newtonianism in the first part of *Génération harmonique* (1737) and its connection to Mairan, *Opticks*, and experiments (as discussed in Chapter 3), this second Newtonian aspect involves the concept of gravitational attraction and the work of Newtonians, such as Voltaire, whose work centered on this concept. As discussed previously, I describe Rameau's use of language like Voltaire's as his "outside" approach to gaining status, as the Newtonian work of Voltaire and others was popular among lay readers at the time. In addition to Rameau's new use of experiments in *Génération harmonique*, his revisions to concepts such as the fundamental bass, the role of the subdominant and modulation[1] also bear witness to his new methodological interests. In this chapter, I demonstrate the degree to which each of those concepts reflects Newtonian rhetoric and principles. In some cases, his theorizations underwent distinct changes between *Nouveau système* (1726) and *Génération harmonique*, changes that seem to reflect the influence of a notion of musical attraction. In other cases, however, his theorizations do not substantially differ from their earlier versions, indicating that in order to lend an air of scientific authority to his treatise, Rameau may have only embraced certain characteristics that were considered Newtonian. Here, as in Chapter 3, we can understand Rameau's Newtonianism as strategic.

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[1] For clarity I will use "modulation" (with quotation marks) to refer to the older concept of harmonic movement within a single key and modulation (without quotation marks) to refer to the more modern definition of harmonic movement between keys.

Rameau's failing relationship with Castel indicates that his perspective had shifted away from one of overt Cartesianism by the 1730s. Though Castel had initially supported Rameau's theoretical endeavours, he began to withdraw his support after the publication of *Nouveau système* in 1726, publishing the negative reviews that led to his polemic with the composer in 1735-1737. His reaction to Rameau's use of experimental science is in keeping with the larger Jesuit reaction to empiricism, Newtonianism, and the association of these issues with Deism, which the church saw as a collective threat to their authority. An increasingly popular religious movement, Deism was imported from England to France in the early 1700s.[2] Deists believed that the empirical study of Nature led to a deeper understanding of the Divine, but they rejected notions of Divine Intervention and Providence.[3] Jesuits and other church leaders associated Deists' empirical study of Nature with Newtonianism, as French Newtonians had emphasized the empirical aspect of Newton's work.[4] Hence, as a Jesuit, Castel was predisposed to dislike Rameau's use of empirical science. Voltaire, on the other hand, viewed the polemic between Rameau and Castel as an opportunity to further the interests of French Newtonians; he entered the dispute to defend the composer and to condemn Castel's anti-Newtonian stance. Adding further fuel to the fire, according to Cyril B. O'Keefe, Voltaire's interests in Locke and Newton bolstered his reputation as a prominent French

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[2] S. J. Barnett, *The Enlightenment and Religion: The Myths of Modernity* (New York: Manchester University Press, 2003), 21.

[3] Ibid., 17.

[4] For more on the Jesuit reaction to Deism, see Shank, *The Newton Wars and the Beginning of the French Enlightenment*, 380ff.

Deist and anti-clerical thinker.[5] By examining the motivations of each author in this polemic, I attempt to explain the complex web of political, religious, and ideological factors that impacted their claims. Voltaire's defense of Rameau from Castel had ramifications for Rameau's public image, as Voltaire implied that Rameau sided with him in the controversy over French science and religion in the 1730s.

Ultimately I show that Rameau's association with French Newtonianism and thinkers like Voltaire had negative consequences. Newtonianism in the 1730s was still fairly controversial. The Academy would go on eventually to adopt and defend Newton's theories, but in the 1730s many aspects of Newtonianism were not institutionally accepted. The Newtonian label likely prohibited Rameau from attaining his apparent goal of becoming a member of the Academy, as is evident from his dedication of *Génération harmonique* to the Academy and his later attempts.[6] Rameau, for his own part, frequently sought support from intellectuals and scientists of various backgrounds; his conflict with Castel shows that those who assisted him at various points did not share the same methodological or philosophical views. Voltaire's defense is an example of how Rameau's work factored into the ongoing cultural tensions surrounding science, religion, and authority in the French Enlightenment.

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[5] See: O'Keefe, *Contemporary Reactions to the Enlightenment (1728-1762)*, 32-35; Shank, *The Newton Wars*, 339.

[6] Rameau also attempted to gain Academy membership through his later treatises, *Demonstration du principe de l'harmonie* (1750) and *Nouvelles réflexions de M. Rameau sur sa démonstration du principe de l'harmonie* (1752). See also Chapter 1, p. 7, for my original discussion on Rameau's attempts to become an Academician.

Voltaire, Castel, and the *Journal de Trévoux*

In the early eighteenth century, J. B. Shank has argued, an increased number of independent periodicals played a significant role in the Newtonian debates. [7] Shank claims that these journals, often lacking institutional affiliations, could publish material more freely in the decades after 1715 (the year that Louis XIV died) than in previous decades.[8] As a result, intellectual discourse itself became less constrained or even polite as the readership and types of available texts broadened.[9] This change in attitude was initially felt more strongly in the Netherlands than in France, as Dutch publishers began to create new francophone journals. Though these journals were sometimes banned in France, they were still widely read, and were perhaps made more popular by their illegality.[10] Despite the new sense of journalistic freedom and the increase in publishing, the French government maintained tight control over the number of journals in circulation during this period, and the creation of new journals still required royal approval. O'Keefe writes that, in spite of the strict publishing laws, religious groups such as the Jansenists openly disregarded State policies and the agencies that enforced them and continued to publish their own materials.[11] O'Keefe claims that this lack of consistency in enforcing publishing laws contributed to the general perception of a weakened French government, while the Church establishment simultaneously feared the

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[7] See Shank, *The Newton Wars*, 120ff. for more on the new press during this time.

[8] Ibid., 123-124.

[9] Ibid.,121.

[10] Ibid.,123.

[11] O'Keefe, *Contemporary Reactions to the Enlightenment (1728-1762)*, 16.

threat of Deism and other new religious movements.[12] According to O'Keefe, given the intertwined relationship between the Church and the French monarchy, religious disunity added to the growing sense of political instability, even though the Crown maintained broad authority.[13]

Among the new journals in France was the *Journal de Trévoux*, founded in 1701 by the Abbé Jean-Paul Bignon (1662-1743) and René-Joseph de Tournemine (1661-1739), both Jesuits from the College of Louis-le-Grand who wanted to create a Jesuit publication dealing with arts and sciences. Despite limitations on the number of new periodicals, the *Journal de Trévoux* was granted royal publishing permission because of the support of the Duc de Maine who sponsored it.[14] Castel served as editor of the journal from 1722-1745. Anonymity was important to the *Journal de Trévoux*; neither authors' names nor editors' names for specific volumes were published in the journal. However, the names and tenures of certain editors, such as Castel, are known. The Jesuits modeled the journal after the secular *Journal des Savants* in that they strove for as objective a tone as possible in their articles and reviews.[15] Despite their relevance to the history of French Newtonianism, mathematical and scientific articles make up a minority of the journal's contents. Many more articles focused on theology, history, and literature. In the issues from 1730, for instance, only about one article per month dealt with science or

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[12] O'Keefe traces this specifically to the Jansenist and Deist movements in France. See O'Keefe, *Contemporary Reactions to the Enlightenment*, 16-17.

[13] Ibid., 17.

[14] O'Keefe, *Contemporary Reactions to the Enlightenment*, 6.

[15] Ibid., 8.

mathematics. The *Journal de Trévoux* mostly served as a way for intellectuals across France to stay abreast of new writings in various fields and countries.

From the beginning of his editorship, Castel used his position to further his own mathematical and scientific agenda and to incite polemics with various institutions. He was known for being harsh in his reviews of others' work, at times excessively so.[16] A consequence of Castel's own methodological orientation, the *Journal de Trévoux* itself was known for publishing work that relied on rigorous mathematics; anything that could be considered metaphysical was suspect.[17] Castel consistently wrote negative reviews of the *Histoire de l'Académie Royale des Sciences*, which at times caused problems for him. For example, he reviewed the *Histoire* of 1730 so harshly that the Academy demanded that the *Journal de Trévoux* issue a formal public apology and terminate whoever was responsible – and they believed that was Castel.[18] The journal issued an apology, but Castel was neither mentioned in it, nor was he fired. Within the developing arena of intellectual debate, Castel stood out for his heated discourse.[19]

Rameau and Voltaire

Apart from their connection to French Newtonianism, Rameau and Voltaire enjoyed a professional and artistic relationship. In the 1720s, Rameau obtained support from Alexandre Le Riche de La Pouplinière (1693-1762), a wealthy Parisian patron of the arts.

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[16] Shank, *The Newton Wars*, 162-163.

[17] Ibid.,196.

[18] Ibid.,207.

[19] Ibid., 132.

Rameau taught keyboard lessons to La Pouplinière's wife and worked as a musician in their household, providing music for their events.[20] Though he was first installed in the house in 1725, he did not feel the full force of his patron's support until 1731 because La Pouplinière was temporarily exiled.[21] Christensen has suggested that Rameau likely was party to some of the discussions among the intellectuals regularly welcomed to La Pouplinière's household.[22] While no specific evidence exists of Rameau's Newtonian education through Pouplinière, it is plausible that his presence there included an exposure to Newtonianism through Voltaire and the other invitees.

La Pouplinière suggested that Rameau collaborate with Voltaire on a new opera[23] and the two collaborated on three stage works.[24] Scholars refer frequently to their opera *Samson*, though public performances of the work were banned due to its supposedly

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[20] When Rameau and La Pouplinière were first acquainted, Rameau worked in his house in Paris. In 1732, La Pouplinière bought a château outside the city where Rameau also worked. I refer to Rameau's employment in La Pouplinière's household without distinguishing between his time in the Parisian mansion and the château. See J.-G. Prod'homme and Theodore Baker, "A French Mæcenas of the Tie of Louis XV: M. de la Pouplinière," *The Musical Quarterly*, vol. 10, no. 4 (October, 1924): 515-516.

[21] Georges Cucuël, *La Pouplinière et la Musique de chambre en XVIIIe siècle* (New York: Da Capo Press, 1971), 59. Rameau scholars disagree somewhat on the dates of Rameau's employment with La Pouplinière. Most scholars, including Christensen, believe Rameau was introduced to La Pouplinière in the 1720s and took his position at the house by at least 1731, though some believe it was later in the 1730s. The 1731 date refers to Rameau's collaborations with Voltaire. Cucuël believes Rameau began his position at the house earlier, in 1725, because of his and La Pouplinière's mutual relationships with the poet and playwright Alexis Piron (1689-1773); he argues that Rameau was less artistically productive during this time because of La Pouplinière's exile that ended in 1730. For more, see also Christensen, *Rameau and Musical Thought in the Enlightenment*, 188, Footnote 62.

[22] Christensen, *Rameau and Musical Thought in the Enlightenment*, 187-88.

[23] Cucuël, *La Pouplinière et la Musique de chambre en XVIIIe siècle*, 63.

[24] Girdlestone notes that Rameau and Voltaire collaborated on three works, including *Samson*, *La Princesse de Navarre* (*comédie-ballet* premiered in 1745), and *La Temple de la Gloire* (*opéra-ballet*, 1745). See Girdlestone, *Jean-Philippe Rameau: his Life and Work*, 443-450.

blasphemous content.[25] Catherine Kintzler suggests that Rameau's and Voltaire's relationship was stormy from the beginning. Each time they collaborated, Voltaire's initial excitement faded when he felt like Rameau did not listen to his input.

Rameau and Castel's Polemic

Before Rameau began work on *Génération harmonique*, he and Castel enjoyed a collegial, professional relationship. Castel initially helped Rameau with his theory of chord motion first set down in *Traité* by introducing him to Pardies's theory of colliding bodies. He also introduced Rameau to the geometric progression that figured prominently in his later treatises. But he reacted negatively to Rameau's work in the 1730s. I focus on two specific criticisms in Castel's initial review essays on *Génération harmonique*: his dislike of Rameau's use of experiments and the disunity in Rameau's revised harmonic system that the experiments supposedly validate. Castel's desire for music theory to be based on rational principles focuses his criticism particularly on Rameau's empirical approach. His emphasis on unity is also evident in his criticisms of Rameau's concepts of subdominant, tonic, and dominant, and the disunity he believes they engender.

In his first critical essay on *Génération harmonique* from 1735, Castel outlines the role of science in Rameau's work before explaining his own creation of the ocular harpsichord (a machine that produced colors, rather than sounds, when the keys were

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[25] Girdlestone, *Jean-Philippe Rameau*, 195-96. Catherine Kintzler suggests that *Samson* is discussed to the exclusion of Rameau and Voltaire's other collaborations because of the rich correspondence they had about this opera. She does not mention the other projects they worked on together. See Catherine Kintzler, "Rameau et Voltaire: les enjeux théoriques d'une collaboration orageuse," *Revue de Musicologie*, T. 67, No. 2 (1981): 140.

struck).[26] As these remarks were published before *Génération harmonique*, it seems that Castel read an early version of the treatise and wanted to state his disapproval in advance of its publication, lest the public think he had supported Rameau's work. He first criticizes Rameau's use of critical observation: "The spirit," Castel argued, "plays more of a part [in music] than the senses."[27] In regard to Rameau's reliance on so-called "natural" principles in his experiments, Castel sarcastically says that:

> We entrench ourselves in what is natural, that is to say, in what to us is natural, that is to say, again, habitual. We do not lack a thousand common occasions to abuse the respectable name of nature, which we most often reduce to monotony and to the most sterile poverty.[28]

Castel's negative review was in part driven by his awareness that Rameau had become more interested in empirically validating his claims. He does not criticize Rameau specifically for being Newtonian, but his disapproving tone indicates an awareness of the change in Rameau's approach.

Castel criticized Rameau further for the lack of unity in his theory of the fundamental bass. Castel clearly found the idea of the fundamental bass compelling, but he reproached Rameau for arguing in *Génération harmonique* that the subdominant was

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[26] Thomas L. Hankins, "The Ocular Harpsichord of Louis-Bertrand Castel; Or, the Instrument that Wasn't," *Osiris*, 2nd series, vol. 9, Instruments (1994): 141-56.

[27] "L'esprit y a plus de part que les sens." Louis Bertrand Castel, "Suite et second partie des nouvelles expériences d'Optique et d'Acoustique, adressées à M. le Président de Montesquieu. Par le P. Castel, Jesuite," *Journal de Trévoux* (August, 1735), 1621; reproduced in *CTW* VI, 70;

[28] "Nous nous retranchons sur le naturel, c'est-à-dire, sur ce qui nous est naturel, c'est-à-dire encore, habituel. Nous ne manquons pas de mille beaux lieux communs pour abuser de ce respectable nom de *nature*, que nous reduisons le plus souvent à la monotonie et à la plus sterile indigence." Ibid., 1623; *CTW*, vol. 6, p. 71.

an essential harmony.[29] In a sense Castel's understanding of the fundamental bass was more rigorous than Rameau's, in that he objected to Rameau's expansion of the acceptable intervals by which the bass could move, as well as the existence of the subdominant. For Castel, only the tonic (*tonique*) and the dominant (*dominante-tonique*) could be considered the fundamentals (or fundamental chords) of the mode. After praising Rameau for further developing the fundamental bass in ways that his predecessors could only glimpse, he wrote:

> But in allowing two, and even three fundamentals in each key – the tonic, the dominant and also the subdominant – he loses sight of the unity [that] nature had given him a glimpse of in the first place: he even contradicts his [own] principles by recognizing the subdominant as the bass of the chord of the added sixth which is not fundamental [since it is built from the supertonic], no matter what invented term with which he qualifies this sixth, which is nothing but a name without meaning and without feature.[30]

In his criticism of *Fa* as a fundamental, Castel clings to Rameau's previous theory of chord motion as explained in *Traité*. In this earlier theory, *Fa* served as the seventh of the dominant chord and was the model for dissonances on other chords, hence its status as the fundamental dissonance. The need for the seventh to resolve created harmonic motion. In his revised theory, Rameau explained that *Fa* could also serve as a chordal root for the subdominant chord and that the subdominant was one of the essential chords of the mode. For Castel, however, *Fa* remained the most significant dissonance: "*Fa* is

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[29] Castel, "Suite et second partie des nouvelles expériences d'Optique et d'Acoustique," 1737; *CTW*, vol. 6, 76.

[30] "Mais en admettant deux et même trois fondamentales dans chaque ton, la tonique, la dominante, et même la soúdominante, il perd de vûë l'unité la nature qui s'étoit d'abord laissée entrevoir à lui: il contredit même ses principes en reconnoissant la soúdominante comme base d'un accord de *grande sixte* qui n'est pas fondamental, de quelque nom *a'ajoutée* qu'il qualifie cette sixte, ce qui n'est qu'un nom sans expression et sans caractere." Ibid., 1636-1637; *CTW*, vol. 6, 75- 76.

the active dissonance [causing tonal motion], the others are passive dissonances."[31] As I have discussed previously, Rameau had modeled his theory of chord motion in *Traité* after Ignace-Gaston Pardies's theory of colliding bodies and the transfer of energy. Castel was likely responsible for Rameau's knowledge of Pardies's work and evidently did not approve of Rameau abandoning it for a new theory of harmonic motion that granted the subdominant the same significance as the tonic and subdominant.

In contrast to what he saw as the disunity of Rameau's concepts of tonic, dominant, and subdominant, Castel hoped to found his own musical system and the ocular harpsichord on the principle of Cartesian unity. Castel wrote that the ocular harpsichord would be the "universal instrument of the senses,"[32] by which "deaf listeners could enjoy music that was originally written for the ear,"[33] thereby unifying sensory experiences. He refers frequently in his writing to Descartes's theory of colours.[34] Instead of using Newton's idea of the correspondence between the colour spectrum and the diatonic scale,[35] Castel built his system on the connection he saw between the three primary colours (red, yellow, and blue) and the major triad. He also wrote that blue

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[31] "*Fa* est la dissonance active, les autres sont des dissonances passives." Ibid., 1639; *CTW*, vol. 6, 76.

[32] Louis-Bertrand Castel, "Clavecin pour les yeux, avec l'art de peindre les sons, et toutes sortes de pièces de musique, Lettre écrite de Paris le 20 Fevrier 1725 par le R. P. Castel, Jesuite, à M. Decourt à Amiens," *Mercure de France*, Nov. 1725: 2552-2577; as cited in and translated by Hankins, "The Ocular Harpsichord of Louis-Bertrand Castel," 143.

[33] Hankins, "The Ocular Harpsichord of Louis-Bertrand Castel," 143.

[34] Louis-Bertrand Castel, "Réflexions sur la nature et la source du sublime dans le discours: Sur le vrai philosophique de discours poétique, et sur l'analogie qui est la clef des découvertes," *Mercure de France*, June 1733: 1309-1322; as cited in Hankins, "The Ocular Harpsichord," 152.

[35] For more on Newton's ideas on the correspondence between colours and music, see: http://www.hps.cam.ac.uk/library/universalharmony/newton.html (accessed July 28, 2014). See also: Isaac Newton, *Opticks or, A Treatise of the Reflections, Refractions, Inflections, and Colours of Light*. 4th ed. (London, 1730. New York: Dover, 1952), 127-128 and 154-158.

should be the "fundamental bass" of "colour harmony" because it was the darkest of the three primary colours.[36] From this we can see that Castel believed strongly in the analogy between colour and music but rejected the Newtonian explanation of that connection in favour of what he believed to be a more Cartesian one.

In July of 1736, Rameau published a heated response to Castel in the *Journal de Trévoux*. Rameau argued that musicians need experience: "The geometer will always be able to distinguish himself there by his calculations, the physicist by his reasonings, the musician by his experience."[37] He cites Castel as having previously approved of the experiments that he sent in advance of the publication of *Génération harmonique*: "You know I am working on it: I even sent you my notes on this subject four or five years ago; you were quite taken by the experiments that I proposed there to support my principle."[38] Despite Castel's criticisms of Rameau's use of empirical observation, Rameau claims that he approved of his experiments in their initial form.

Rameau also responds to Castel's previous accusations that he both misread and imitated Kircher by criticizing Castel's translation of one of Kircher's Latin texts. Rameau's criticism likely offended the Jesuit scholar whose Latin was almost certainly

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[36] Hankins, "The Ocular Harpsichord of Louis-Bertrand Castel," 152.

[37] "Le Géometre pourra toujours s'y distinguer par les calculs, le Physicien par ses raissonnemens, et le Musicien par son expérience." Jean-Philippe Rameau, "Lettre de M. Rameau au R. P. Castel, au sujet de quelques nouvelles réfléxions sur la Musique, qu le R. P. Castel a inserées dans le mois d'Août (ii. Partie) et de Septembre 1735 de ces Memoires," *Journal de Trévoux* (July, 1736), 1,709; reproduced in *CTW*, vol. 6, 92.

[38] "[Vous] sçavés que j'y travaille, je vous communiquai même mes manuscrits sur ce sujet, il y a quatre ou cinq ans; vous y fûtes séduit des expériences qu j'y propose pour appuyer mon principe." Ibid., 1698; *CTW*, vol. 6, 88.

far better than his own.[39] The question, however, of Rameau's relationship to Kircher points to the larger lineage of his work in connection to previous harmonic theories. For Castel, Kircher's theory was appropriately rationalist and would have reflected a Cartesian (or pre-Newtonian) sensibility. Rameau's earlier work had displayed the same sensibility, but this changed in *Génération harmonique*. For Rameau to separate himself from Kircher represented a larger break with the scholastic tradition of thought. In Castel's eyes, Rameau was wrong to separate himself from this tradition. In a seemingly contradictory move, Castel also accused Rameau of poorly imitating Kircher's *basse continue*, a concept similar to the fundamental bass. Rameau defended his fundamental bass saying that he did not simply copy Kircher. He accuses Castel of misunderstanding his theory, saying that had Castel actually understood the fundamental bass, he would have easily distinguished between it and Kircher's *basse continue*.[40]

Rameau ultimately argued that *Génération harmonique* itself would be his last response to Castel: "I will not explain myself on the objections that you have made elsewhere; the work in question will be my response."[41] He fervently defended his use of experience as the most appropriate method to confirm his work: "Our senses are limited, and it is up to us to know how to adapt ourselves to what experience teaches."[42] He added that once our minds have heard the *corps sonore*, it always stays with us: "Our

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[39] Ibid., 1696; *CTW*, vol. 6, p. 88.

[40] Ibid., 1701; *CTW*, vol. 6, 89.

[41] "Je ne m'explique point sur les objections que vous me faites d'ailleurs; l'ouvrage en question sera ma réponse." Ibid., 1704; *CTW*, vol. 6, 90.

[42] "[Nos] sens sont bornés, et c'est à nous de sçavoir nous y conformer sur ce que l'expérience nous apprend." Ibid., 1707; *CTW*, vol. 6, 91.

imagination will not impede that which always resonates, [and] as a result the same core of harmony will still reign."[43] From Rameau's defense of his experiments, we can see how he used science to position himself and portray his theory in an elevated way.

A few months later, in September 1736, Castel responded scathingly: "Since M. Rameau only addresses me [in] his letter as a route to publicity, I restrict myself to simple remarks, in which form the reply presents itself at first glance."[44] He describes Rameau as preoccupied with what others think of him: "The public has no interest at all in these characters who are only good for feeding on the pride of interested others."[45] He reacted particularly strongly to Rameau's comments about Kircher. Castel rejected the idea that he had badly translated Kircher's work[46] and he denied Rameau's previous claim that Castel and Kircher knew one another: "For [Rameau] wishes to prove that I knew [the work of] this writer [Kircher] fifteen years ago, yet he only proves it through presumption and conjectures."[47] Further refuting Rameau's account of his knowledge of Kircher's writing, he says that he had not studied Kircher's work for twenty years, as Rameau also claimed. Instead, Castel claims that Rameau thought often of Kircher's work while writing *Traité*, and that "M. Rameau had the naivety to admit to me that he himself had

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[43] "Notre imagination n'empêchera pas que ce qui résonne toujours, par consequent il y régnera toujours le même fond d'harmonie." Ibid., 1,708; *CTW*, vol. 6, 92.

[44] "Comme M. Rameau ne m'adresse sa Lettre que par la voye de la Publicité, je m'en tiens aux simples Remarques, sous la forme desquelles la Réponse s'en présente au premier coup d'oeil." Louis Bertrand Castel, "Remarques du P. Castel, sur la Lettre de M. Rameau," *Journal de Trévoux* (September, 1736), 1,999; *CTW*, vol. 6, 90.

[45] "Le Public ne prend aucun intérêt à ces personalités qui ne sont bonnes qu'à *repaître l'amour propre* des personnes intéressées." Ibid., 1999; *CTW*, vol. 6, 93.

[46] Ibid., 2,006; *CTW*, vol. 6, 95.

[47] "Car il veut prouver que je connoissois cet Auteur il y a quinze ans, et il ne le prouve que par des présomptions et par des conjectures." Ibid., 2004; *CTW*, vol. 6, 95.

known [the work of] Kircher [while living] in the provinces."[48] Rameau's private admission to knowing Kircher's work was proof, for Castel, that Rameau had simply imitated Kircher's bass to create the fundamental bass in *Traité*.

Castel redoubled his criticism of Rameau's fundamental bass by saying, "[It] has neither the precision, nor the clarity, nor above all the scope, strength and the energy, and is nothing more, as I have said on other occasions, than a germ of discovery."[49] Citing his own support for Rameau's past endeavours Castel says, "I will not be embarrassed by these little excesses of youth."[50] In Castel's criticisms of the fundamental bass we can see his disappointment that Rameau's work did not live up to his earlier hopes: "I re-read my Abstracts. They promise miracles; but it was only the remarks of Oracles."[51] Though he had believed in the potential of Rameau's ideas, Rameau had not seen them through as Castel had wished. Castel was willing to admit that the fundamental bass could be useful, but he strongly believed that Rameau had not thoroughly developed it in *Génération harmonique*. In his descriptions of Rameau's unfulfilled promises, he mocks Rameau's ability to theorize the most fundamental aspect of his theory of harmony. In this critique, Castel's criticisms became especially personal.

Castel also reacted negatively to the new version of "modulation" in *Génération harmonique*. In this treatise, Rameau continued to use the term "modulation" to refer to

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[48] "M. Rameau avoit eu la candeur de m'avouer, qu'il avoit lui-même connu Kircher en Province." Ibid., 2006; *CTW*, vol. 6, 95.

[49] "Elle n'en a ni la precision, ni la netteté, ni surtout l'étenduë, la force et l'énergie, et que ce n'est, comme je l'ai dit en d'autres occasions, qu'une semence de découverte." Ibid., 2009-2010; *CTW*, vol. 6, 96-97.

[50] "Je ne rougirai pas tout seul de ce petit excès de jeunesse." Ibid., 2011; *CTW*, vol. 6, 97.

[51] "Je relus mes Extraits. Ils promettoint des merveilles; mais ce n'étoient que jes Commentaires d'Oracles." Ibid., 2013; *CTW*, vol. 6, 98.

harmonic progression within a key; however, he also used it to refer to the more modern conception of modulation between keys. Understanding "modulation" (in the older sense) as a synonym for "chord motion" reveals the source of Castel's distress. He does not approve of the subdominant as an essential harmony of a key and thus he cannot accept Rameau's later theory of "modulation" in which the subdominant played a more significant role. Castel also finds Rameau's explanation of harmonic movement to be circular and confusing:

> I was most astonished to find myself face-to-face with what the philosophers call the 'vicious circle' [*le Cercle vicieux*]. For to understand modulation I needed the bass; and to make this bass I would have needed to understand modulation.[52]

Castel argued that Rameau's explanations of harmonic motion and the overlapping concepts of the fundamental bass and "modulation" were illogical.

Returning to a similar criticism of *Traité*, Castel complains that he told Rameau repeatedly that, "the public is due the clarifications, the introductions, and the supplements that M. Rameau added to his *Traité de l'Harmonie*, and even the material of modulation."[53] He says that Rameau responded to his requests with a variety of excuses: "He always promised me to exhaust it. Sometimes he replied to me that everything was already in his books; other times he agreed that he only had it sketched out."[54] Further, given his criticisms, he says, he would never have approved of the *double emploi*:

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[52] "[Je] fus fort étonné de me trouver vis-à-vis de ce que les Philosophes appellent *le Cercle vicieux*. Car pour connoître la modulation, j'avois besoin de la Basse; et pour faire cette Basse, il m'auroit fallu connoître la modulation." Ibid., 2,013; *CTW*, vol. 6, 98.

[53] "[que] le Public doit bien des éclaircissemens, des introductions, des supplemens que M. Rameau a ajoütés a son Traité d'Harmonie, et à la matiere même de la modulation." Ibid., 2,015; *CTW*, vol. 6, 98.

[54] "Il me promettoit toûjours de l'épuiser enfin. Quelquefois il me répondoit que tout étoit déja dans ses Livres: d'autrefois il convenoit qu'il ne l'avoit qu'ébauchée." Ibid., 2015; *CTW*, vol. 6, 98.

> M. Rameau, who seems to have forgotten all that passed between him and me, aside from my initial compliments, touches on a sensitive point when he says that I contented myself on his explanations of the added sixth chord associated with his fundamental chords. But there is still deception here; and when M. Rameau makes it understood that he knows not what to say of these the things, he is not really doing himself justice.[55]

Castel finds Rameau's explanations of the *double emploi* to be inadequate and he suspects that Rameau misunderstands the concept himself. Castel's reactions to Rameau's revised theories of modulation and the fundamental bass thus express his most profound disappointments in *Génération harmonique.*

Just as in his initial review, here too Castel focused a large portion of his criticism on Rameau's use of experiments. Restating his disapproval, Castel also denies Rameau's claim that he had approved of the experiments, particularly the ones involving a set of tongs. Castel writes,

> As for the experiments with the organ [pipe] and the tongs that he boldly claims to have been to my liking, I have never, so far as I know, spoken of tongs, and having not been an organist, nor an organ builder, it is necessary for me to consult those who are."[56]

It is worth noting that these remarks come from Castel's second review essay that was published in 1736, still months before the publication of *Génération harmonique*. Again we see Castel attempting to separate himself from Rameau's work and revoke any previous approval he had given it. His list of criticisms grew in the second essay. Building on his criticisms of experimental science, Castel also criticizes Rameau's use of

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[55] "M. Rameau qui semble avoir oublié tout ce qui s'est passé entre lui et moi, hors mes premiers complimens, touche un point délicat lorqu'il dit, que je me suis contenté de ses raisons sur l'accord de grande sixte associée à ses accords fondamentaux. Mais il y a du tour encore ici; et quand M. Rameau fait entendre qu'il ne sçait que dire les choses, il ne se rend pas tout-à-fait justice." Ibid., 2022; *CTW*, vol. 6, 101.

[56] "Pour ce qui est des Expériences de *l'Orgue* et de le *Pincette*, qu'il dit finement avoir été de mon gout, je n'ai, que je sçache, jamais parlé de Pincette, et n'étant pas Organiste ni Facteur d'Orgue, il faut bien que je consulte ceux qui le sont." Ibid., 2012; *CTW*, vol. 6, 100.

tables in both *Nouveau système* and *Génération harmonique*: "[He] gave us some tables of harmonic numbers that lead to nothing."[57] Nor does he believe Rameau has given him proper credit for telling him about the geometric progression, on which the tables are based.[58] Finally, he closes by rejecting Rameau's science. Castel returns to Rameau's claim that, just as geometers are distinguished by their calculations, musicians distinguish themselves by their experience. He says, "By *your experience*, I say, and not by *experiments*, which belong to the physicist, just as calculations belong to the geometer."[59] Here Castel seems to draw on the dual meaning of the French word "*expérience*," referring both to experience, as in English, but also to experiments of a scientific nature. He shows that Rameau is trying to be empirical but failing because he tries to generalize from his experience, which is not broad enough to be meaningful. Castel clearly rejects Rameau's inductive approach.

Through all his claims and sniping, Castel consistently portrays himself as a victim. Even after saying that Rameau only argued with him for publicity, Castel writes that Rameau merits admiration and that in the fifteen years they have known each other, he has genuinely appreciated Rameau's music.[60] Such compliments were intended, perhaps, to show how Castel believed himself to be supportive of Rameau, and

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[57] "[Il] nou donna…quelques Tables de nombres harmoniques qui ne vont à rien." Ibid., 2020; *CTW*, vol. 6, 100.

[58] Ibid.

[59] "Par ton expérience, dis-je, et non par *des expériences*, qui appartiennent au Physicien, comme les calculs au Geometre." Ibid., 2026; *CTW*, vol. 6, 102.

[60] Ibid., 2000-2001; *CTW*, vol. 6, 93-94.

undeserving of his anger. He claims that Rameau's criticisms of his works are too severe, as he is not a musician of the same calibre as Rameau:

> [Rameau] takes me for a professional musician, forgetting that he has hardly seen me studying music except with him, and exclusively with him, in idle moments which, placed end-to-end, would not be the amount of a full year of serious study.[61]

By accusing Rameau of unfairly overestimating his musical knowledge, Castel shifts the focus to Rameau's theoretical mistakes and inadequate preparation and away from his own shortcomings. These comments, meant to defend against Rameau's criticisms, seem especially feeble given Castel's attacks in his 1735 essay. In light of his severe criticism of *Génération harmonique* before its publication, Rameau's anger toward him is understandable.

By the time of their final public exchanges, the disagreement had shifted from the content of the texts they produced to the character and capabilities of the individuals themselves. In 1738, Rameau reacted with a second and final strongly worded response to Castel's September review and to another summary of his work that Castel published in December 1737[62] (this, despite Rameau's previous claim that *Génération harmonique* would be his last word in the debate). He immediately states that Castel's claims were unfounded. Responding to Castel's criticisms of his calculations, and in particular his tables of the geometric progressions and chord affinities, Rameau asks, "Is it not, then, with [Castel] that I learned these [geometrical] arrangements?...What has he taught me

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[61] "[Il] me prend pour un Musicien de profession, oubliant qu'il ne m'a guéres vû étudier la Musique que pour lui et presqu'uniquement avec lui, dans des momens perdu, lesquels mis bout-à-bout ne seroient pas la valeur d'une bonne année d'étude sérieuse." Ibid., 2005; *CTW*, vol. 6, 95.

[62] [R.P. Castel] *Journal de Trévoux* (December, 1737): 2142-2167.

then?"[63] In response to Castel's own efforts to create a harmonic system, also called "*génération harmonique*," Rameau protested, "As for his so-called 'generations *harmoniques*,' it is but a chimera refitted with a specious title that he only wishes to set against the title of my last work, and baseless."[64] Rameau defended his ability to perform his straightforward experiments: "What! This is the author of Universal Mathematics who contests the glory of my 'feeble' discoveries? With me, who is but a simple musician? I must have succeeded, there is the proof."[65] In this way, Rameau argued that he should be taken seriously as both a musician and a scientific thinker. Responding to Castel's criticism of mathematical errors in the treatise, Rameau criticized what he deemed Castel's overuse of calculation: "One can also be consumed in geometry and in calculus without knowing how to justly apply them."[66] The ferocity of their exchanges is, at times, noteworthy.

Rameau continued to defend the "natural" basis of the *corps sonore*, and by implication, his entire theory. Responding to Castel's claim in his first review that certain of his concepts were arbitrary, Rameau wrote:

> Everything that belongs to a science must correspond to its principle. If not, either the principle is wrong, or that which does not correspond may not belong to this

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[63] "Ce n'est donc pas avec lui que j'ai pris ces arrangemens?...Que m'a-t-il donc enseigné?" J.-P. Rameau, "Remarques de M. Rameau, sur l'Extrait qu'on a donné de son livre intitulé: *Génération harmonique*, dans le *Journal de Trévoux,* Décembre 1737," *Le Pour et Contre* (1738), 74; *CTW*, vol. 6, 172.

[64] "A l'égard de ses prétendues *generations harmoniques,* ce n'est qu'un vain fantôme revêtu d'un titre spécieux, qu'il veut seulement opposer au titre de mon dernier ouvrate, et nullement au fond." Ibid., 76; *CTW*, vol. 6, 172.

[65] "Quoi! c'est Auteur de Mathématiques universelles qui me dispute la gloire de mes foibles découvertes? à moi, qui ne sui qu'un simple Musicien? Il faut que j'aie réussi; c'en est la preuve." Ibid., 77; *CTW*, vol. 6, 172.

[66] "One peut aussi être consommé dans la Géometrie et dans le Calcul sans en sçavoir faire une juste application." Ibid., 86; *CTW*, vol. 6, 175.

> science. For that which is arbitrary, the principle gives nothing of itself: there is an original and invariable order in nature on which everything must be established, and from which it is always necessary to depart. […] The ratios which must be found there from one note to the next are not dependent on our fantasy: it is for nature alone to determine them.[67]

For Rameau, the natural principles at the heart of his theory guaranteed its logic and order. He reasoned that, as every aspect in his harmonic system was determined by nature, arbitrariness was impossible. The metaphysical status of the *corps sonore* did not make it any less physical or natural, Rameau argued, as it was still the consequence of harmony and physics: "The supposition that [there is] a shrouded metaphysics was absolutely necessary here for the writer, to be able to quickly go over the progressions he recalled there, which reflect the subject of his studies."[68] Here Rameau argues that Castel writes his theory off as metaphysical so that he can dismiss it more easily.

Rameau's final response to Castel also took up the earlier criticism of the arbitrariness of temperament in *Génération harmonique*. He claims that Castel's arguments are incorrect because, "the core of harmony, that is the fundamental bass, is precisely the metaphysical principle upon which alone one might determine the arbitrariness that presents itself in the physics of temperament."[69] He adds that both the fundamental bass and temperament behave the same way with voices and instruments

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[67] "Tout ce qui appartient à une Science doit se rapporter à son principe; si non, ou ce principe est faux, ou ce qui ne s'y rapporte pas, ne peut appartenir à cette Science. Pour ce qui et de l'arbitraire, le principe n'en donne point: il y a un ordre primitif et invariable dans la nature, sur lequel tout doit être établi, et dont il faut nécessairement partir. […] Les rapports qui doivent s'y trouver d'un son à l'autre, ne dépendent point de notre fantaisie; c'est à la nature seule à les determiner." Ibid., 80; *CTW*, vol. 6, 173.

[68] "La supposition d'une Métaphysique enveloppée, étoit absolument nécessaire ici au Journaliste, pour pouvoir passer rapidement sur les progressions qu'il y rappelle, et qui sont le sujet de son Histoires." Ibid., 80-81; *CTW*, vol. 6, 173.

[69] "le *fond d'harmonie*, c'est-à-dire, la Basse fondamentale, est justement le principe métaphysique sur lequel seul on puisse determiner l'arbitraire qui se présente dans le physique du Tempérament." Ibid., 82; *CTW*, vol. 6, 174.

and that the fundamental bass clarifies any arbitrariness resulting from temperament. "It is, then, to the fundamental bass alone to give order to arbitrariness, to set it, and to determine of itself the nature of temperament."[70] Rameau embraces the metaphysical quality of the fundamental bass, happily mingling metaphysics and acoustics, both of which he believes connect his ideas to nature.

In this final letter to Castel, Rameau addresses his criticisms of the subdominant. After accusing Castel of trying to destroy the concept of the *double emploi*, Rameau writes, "The addition of the dissonance to the dominant harmony or that of the subdominant is so bound up with the same principle [of the *corps sonore*] that it must agree completely or deny utterly."[71] In other words, Rameau believed he could add the dissonance of the major sixth to the subdominant because its connection to his principle of the *corps sonore* made it natural. Because the sixth was an inversion of the third found in natural resonance of the *corps sonore*, Rameau considered the added sixth on the subdominant to be natural. What is true for the dominant chord must also be true of the subdominant, according to Rameau: thus the subdominant chord must also be eligible to contain a dissonance. Rameau rebuts Castel's argument against the *double emploi* by simply saying that the chord is fundamental:

> For in the end the *double emploi* gives the added sixth chord the form and the foundation of a seventh chord. It exists fundamentally, this double employment;

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[70] "[C'est] donc à cette seule Basse fondamentale, de donner la loi à l'arbitraire, de le fixer, et de déterminer par elle-même, la nature du Tempérament." Ibid., 82; *CTW*, vol. 6, 174.

[71] "L'addition de la Dissonance à l'Harmonie de la Dominante et à celle de la Sous-dominante, est tellement enchaînée au même principe, qu'il faut tout accorder ou tout nier." Ibid., 92; *CTW*, vol. 6, 177.

> everyone uses it, the ear suggests it, even though the received rules seem to contradict it.[72]

As with other aspects of his argument, Rameau's justification is simply that something is a certain way because *that is the way it is.* His theory is logical, according to him, because it is natural (even though his conviction is supported only by his fixation on the first eight partials of the overtone series). As he believes he has adequately proven its natural origin, he need not argue further.

Rameau also responded to Castel's comments about "modulation" by saying, again, that the fundamental bass and "modulation" *must* exist together because they imply each other. In order to explain the relationship between "modulation" and the fundamental bass, Rameau explains that each melody implies a fundamental bass that "modulates" (or moves) a certain way, and the "modulation" of each fundamental bass implies a melody:

> In effect if modulation arises originally in the fundamental bass…if the tune is but a composite of this modulation, if, as a result, the one and the other are but a whole, and they arise equally from this same fundamental bass that is within us, which suggests them to us. This modulation, then, resides with the tune, and it is, from now on, but a matter of recognizing them there to have at the same time the fundamental bass of which the one and the other emanate.[73]

He goes on,

> In this case "modulation" is everything the Generator [fundamental bass] and the by-product ["modulation" and melody] have most in common between them; it is

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[72] "Car enfin le double emploi rend à l'accord de grande Sixte la forme et le fond d'un accord de septiéme. Il existe fondamentalement, ce double emploi; chacun le pratique, l'oreille le suggére, quoique les regles en usage semblent le contredire." Ibid., 93; *CTW*, vol. 6, 177.

[73] "En effet si la Modulation naît primitivement de la Basse fondamentale […]; si le Chant n'est qu'un composé de cette Modulation; si par consequent l'un et l'autre ne sont plus qu'un tout, et s'ils naissent également de cette même Basse fondamentale qui est en nous, qui nous les suggére; donc cette Modulation existe avec le Chant, et il ne s'agit plus qu de l'y reconnoitre pour avoir en même tems la Basse fondamental dont l'un et l'autre émanent." Ibid., 94-95; *CTW*, vol. 6, 178.

> the single index that this Generator had imprinted in its by-product in order that it could be recognized: it is, then, through this single index that the fundamental bass of a given tune can be found.[74]

In trying to clarify the interrelationship of "modulation," melody, and the fundamental bass, Rameau binds them together more strongly. For Rameau, the fundamental bass generates both melody and "modulation," yet melodies imply a certain fundamental bass. The circular logic that Castel criticizes as a failing of the theory is what Rameau identifies as its essential quality.

Voltaire's Response to Castel

In June 1738, Voltaire entered the polemic. He published a letter defending Rameau that drew party lines between himself and Castel, with Rameau clearly on Voltaire's side. Voltaire certainly wanted to defend Rameau; they were collaborators, and Voltaire believed in Rameau's musical genius.[75] However, it is clear that Voltaire published it as much to publically condemn Castel as to defend Rameau, especially given their history of disagreements (discussed below). This letter provided Voltaire with an opportunity to criticize Castel for not supporting Newtonian science.

Castel and Voltaire had a complex and fraught relationship. Before Castel's polemic with Rameau, the *Journal de Trévoux* had already published reviews of

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[74] "La Modulation est en ce cas tout ce que le Génerateur et le produit ont de plus commun entre eux; c'est le seul indice que ce Générateur ait imprimé dans son produit pour qu'il puisse y être reconnu: donc c'est par ce seul indice que la Basse fondamentale d'un Chant donné peut être trouvée." Ibid., 95; *CTW*, vol. 6, 178.

[75] Voltaire frequently praises Rameau in his letters to other individuals in the 1730s. See for example: Voltaire [François Marie Arouet], "*Voltaire [François Marie Arouet] to Nicolas Claude Thieriot: Saturday, 17 December 1735 — [letter]*," In *Electronic Enlightenment*, edited by Robert McNamee et al. University of Oxford. <http://www.e-enlightenment.com.proxy1.lib.uwo.ca/item/voltfrVF0870288_1key001cor/>.

Voltaire's *Lettres philosophiques* in 1735. Voltaire's *Lettres* was considered radical at the time because of his explicit support of Newton, Locke, Deism, and English philosophy.[76] Though many Jesuits would rather have ignored *Lettres philosophiques* than draw attention to it with a negative review,[77] it became too popular to ignore. In the *Journal de Trévoux*'s anonymous review from January 1735, the author accused Voltaire of only attempting to spread his personal dogma about subjects like science and philosophy that, in fact, were beyond his understanding.[78] It is possible that Castel wrote the review, though even if he did not write it, he certainly approved its publication.[79] Voltaire and Castel's troubled relationship reflected tensions between the Church and science more broadly, an issue I will explore in what follows.

As Voltaire enters the Rameau-Castel polemic, he tells Rameau that Castel only wanted to convert him to his own side: "He has thought only to humble you, preferring to sanctify rather than instruct you."[80] He goes on, "But how have you been able to dispute Castel? Truly, it is like battling against a Bellerophon. Think, Sir, of your reckless

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[76] O'Keefe, *Contemporary Reactions to the Enlightenment*, 37; see also: Shank, *The Newton Wars*, 303-304.

[77] Ibid., 36-39.

[78] "Lettres servant de réponse aux *Lettres Philosophiques* de M. de Votaire, Brochure in 12. pp. 82. Sans nom d'Auteur ni d'Imprimeur," *Journal de Trévoux* (January, 1735): 97.

[79] Ibid.

[80] "[Il] n'a songé qu'à vous abaisser, aimant mieux vous sanctifier que vous instruire." Voltaire, "Lettre à Mr. Rameau" (June, 1738), 1; *CTW*, vol. 6, 180.

enterprise."[81] With characteristic sarcasm, Voltaire reduces all of Castel's explanation of his ocular harpsichord to three simple statements:

> [With] what contempt to humankind does he deign to dismantle logical *Lemmes,* theorems, and *Scholies*: 1. That men enjoy pleasure. 2. That painting is a pleasure. 3. That yellow is different from red, and a hundred other thorny questions of this nature.[82]

In this foray, Voltaire was likely drawn to Castel's attacks on Rameau's new interest in experimental science, given the association of empiricism with Newtonianism. Among his criticisms of Castel, Voltaire mentions Castel's opposition to the idea of gravitational attraction, saying that Castel had combatted one of the best demonstrations of the validity of Newtonian physics.[83] While Voltaire does not explicitly connect Rameau with Newton, he brings gravitational attraction into the discussion to demonstrate that Castel has been wrong on other matters beyond his treatment of *Génération harmonique*. What's more, Voltaire chose to attack Castel's Cartesianism (or his opposition to Newton) through a public letter to Rameau, knowing that Castel and other members of elite society would read it. In doing so, he draws Rameau into a discussion in which he had little previous involvement. By bringing Newtonian physics into the discussion, Voltaire broadens the debate to include more than just the state of harmonic theory and implies that he and Rameau are on the same side of a larger, ideological conflict.

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[81] "[Mais]comment avez-vous pû disputer contre R. P. Castel? En verité, c'est combattre contre Bellerophon. Songez, Monsieur, à votre témaire entreprise." Ibid.

[82] "[Quelle] condescendence pour le genre humain, daigne-t-il démontrer par Lemmes, Théorêmes, Scholies, 1. Que les hommes aiment le plaisir. 2. Que la Peinture est un plaisir. 3. Que le jaune est different du rouge, et cent autres questions épineuses de cette nature." Ibid., 2; *CTW*, vol. 6, 181.

[83] Ibid., 3; *CTW*, vol. 6, 182.

Voltaire's rhetoric is significant in that he speaks to Rameau personally and does not treat any one of Rameau's ideas in particular. Rather than defend Rameau from Castel, Voltaire commiserates with him as another victim of Castel's diatribes. He calls Castel the "Don Quixote of Mathematics," because he thinks so much of himself and loves to fight what he believes to be giants.[84] In addition, Voltaire criticizes Castel personally, saying that he does not sufficiently understand his own material. He accuses Castel of only trying to obtain glory through fighting, whether against the Newtonians, the Leibnitzians, or other groups. Once Voltaire turns his criticism to Castel's anti-Newtonian stance, Rameau conspicuously disappears from the text. As Voltaire focuses on Castel's failings as a scientist, it becomes clear that Rameau was an unknowing accessory to a larger confrontation between Voltaire – pro-Newtonian and anti-cleric – and Castel, the Cartesian Jesuit. Finally, Voltaire tells Rameau not to trouble himself with Castel, suggesting rather dramatically that he let Castel's thoughts be entombed in the *Journal de Trévoux*, implying that the journal was a burying ground for lifeless ideas. He tells Rameau not to bother responding: "Imitate the universe, Monsieur, do not respond to him."[85] From Voltaire's letter we can see that he was not so much interested in insinuating that Rameau was a Newtonian, but rather in attacking Castel for his hopelessly anti-Newtonian stance.

Newtonianism and the Fundamental Bass, Modulation, and *Double Emploi*

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[84] Ibid., 4; *CTW*, vol. 6, 183.

[85] "Imitez l'Univers, Monsieur, ne lui répondez pas." Ibid.

Having focused on the context of and changes in Rameau's theories, as well as on some of the social and political implications of those changes, I will now consider the extent of the changes in Rameau's harmonic theory in the 1730s. By the time of *Génération harmonique*, the concepts of fundamental bass, modulation, and *double emploi* each underwent some degree of revision. By tracing the development of these concepts through *Traité*, *Nouveau système*, and *Génération harmonique*, we can see that Rameau's theory reflects changes in mechanical physics that took hold in the 1720s and 1730s, including attractionist concepts of motion. Yet in other ways, his theory maintains the original ideas set out in *Traité*. From the progression of his thought, it becomes clear that although Rameau altered the method by which he explained and demonstrated his theories, his core ideas remained consistent throughout. We can observe certain Newtonian characteristics and terminology, though these proclivities do not indicate that he self-consciously moulded his theory to make it appear Newtonian. Still, we can speculate as to why he would have included these characteristics and terms, including their potential personal and professional benefit.

In *Traité*, Rameau's theory of harmonic motion reflects certain Cartesian principles. Rameau quotes Descartes to explain how the arithmetic divisions of a string may be represented as mathematical ratios.[86] These ratios happen to include the intervals of the perfect chord, and, for Rameau, those same intervals are the only acceptable intervals of harmonic motion in a progression (or, "modulation" within a single key). Rameau writes,

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[86] Jean-Philippe Rameau, *Traité de l'harmonie réduite à ses principes naturels* (Paris: J. B. C. Ballard, 1722), 3-5; Philip Gossett, trans., *Treatise on Harmony* (New York: Dover, 1971), 5-7.

> "The fifth…should be considered the interval best suited to the bass."
> "What we say about the fifth should also be understood to apply to the fourth, which always represents [the fifth]."
> "Since the fifth is constructed of two thirds, the bass, in order to hold the listener in an agreeable state of suspense, may be made to proceed by one or several thirds, and consequently by the sixths which represent these thirds."[87]

Thus the fundamental bass could only move by the consonances that Rameau had determined to be generated by the fundamental sound.[88]

In cases where the bass appears to move otherwise, Rameau interpreted an "interpolated," unnotated bass, revealing that the underlying bassline did, in fact, comply with the principles of the fundamental bass.[89] As a quasi-reduction of the bassline of a given progression, the fundamental bass controlled harmonic motion from the bottom up by generating possible basslines, further extending the idea that all musical motion and harmonic content derived from the intervals of a single chord, itself derived from ratios. In this way we can see Rameau striving to create a system based on the principle of unity that was central to Cartesian thought. In *Traité*, upper voices simply followed the bass, as Nature intended; melody was thus a consequence of harmony.[90]

The significant role of Pardies' theory of colliding bodies in *Traité* also points to Rameau's Cartesian orientation in this earlier treatise. Following Pardies, Rameau

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[87] "[On] doit regarder d'abord la Quinte comme l'intervale qui luy convienne le mieux." "[Ce] que nous disons de la Quinte doit s'entendre aussi de la Quarte qui la represente toûjours." "[Ensuite] pour tenir l'Auditeur dans un suspension agréable, comme la Quinte est compose de deux Tierces, l'on peut faire proceder la Basse par une ou plusiers Tierces; et par consequent par les Sixtes qui representent ces Tierces." Ibid., 50-51; Gossett, 60.

[88] Ibid., 3-14; Gossett, 5-17.

[89] For more on the fundamental bass as analytical tool, see Allan Keiler, "Rameau's Fundamental Bass." In *Music Theory, Special Topics*. New York: Academic Press, 1981.

[90] Rameau, *Traité de l'harmonie*, 52 ; Gossett, trans., *Treatise on Harmony*, 61.

imagined tones in a progression to behave like solids that transfer energy upon colliding. In *Traité*, Rameau theorized that the desire for resolution of the seventh impelled the progression forward; as all non-tonic chords were implicit seventh chords (called *dominantes*), their need to resolve and their subsequent collisions were the primary cause of harmonic motion.[91] In this way, Rameau was able to theorize harmonic motion with a specific cause evidently based in the principles of Pardies, himself a Cartesian physicist. Christensen has reasonably suggested that Castel likely told Rameau of Pardies's work, as the Cartesian aspects of Rameau's theories drew Castel's interest.[92]

Rameau's philosophical affinity in *Traité* is explicit in his references to Descartes and citations of the work of Cartesians like Pardies, whose Cartesian orientation would have been well known. These factors indicate that he took a strong interest in connecting music theory with accepted scientific principles of the time. Many of Rameau's Cartesian ideas from *Traité* remained intact in *Nouveau système* (1726). In this treatise Rameau treated triads and seventh chords in much the same ways as he had in *Traité*, with the seventh as the source of all dissonance.[93] In fact, this treatise can be said to share more principles and sources with *Traité* than with *Génération harmonique* that followed it. Glenn Chandler cites Rameau's references to Zarlino in *Nouveau système* as evidence of

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[91] Ibid., 53; Gossett, 62. Christensen clarifies that the performer or listener was often responsible for "imputing" a seventh on chords where it was not literally notated. He argues that Rameau did not follow this rule when writing figures for his own basslines and that, contradictory as it may seem, he probably never meant for every non-tonic chord to have a seventh in actual musical works. See Christensen, *Rameau and Musical Thought in the Enlightenment*, 129-132.

[92] Christensen, *Rameau and Musical Thought in the Enlightenment*, 109.

[93] Jean-Philippe Rameau, *Nouveau système de musique théorique*, 5; Glenn Chandler, "Rameau's *Nouveau système de musique théorique,* 187-8. Unless otherwise noted, I will use Chandler's English translations.

his Cartesianism.[94] Though Rameau used some of the language that appeared later in *Génération harmonique*, he maintained the same Cartesian perspective in *Nouveau système*,[95] likely for the same reasons he had adopted in *Traité*: in 1726, the tension surrounding Newtonianism had not yet reached the intensity it would achieve in the 1730s. While the public enthusiasm for experimental science was on the rise in the 1720s, Newtonianism per se was not yet popular or controversial. Rameau's references to Descartes or Cartesian principles, on the other hand, served to make him seem knowledgeable of Cartesian mechanics.

One main difference between *Nouveau système* and *Traité*, however, is Rameau's new interest in the geometric triple progression as the source of the three fundamental sounds of the mode. Recall from the polemic discussed earlier that Castel told Rameau of the geometric progression, but disapproved of Rameau's application of it. Rameau used the geometric progression to justify his revised theory of the fundamental bass and the subdominant as a fundamental harmony, none of which was convincing to Castel. In *Nouveau système*, Rameau aligned the fundamental chords of the mode with consecutive terms of the geometric progression (such as 3 : 9 : 27). Whereas the essential chords in *Traité* were based on the first, third, and fifth notes of the mode, the geometric progression emphasized fifth relationships. Rameau writes,

> The progression or the advancement of the fundamental sound will be discovered in this continued geometric proportion {ut sol re}, [1 : 3 : 9], as we announced at

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[94] Ibid., 11; Chandler, 200-201.

[95] Christensen notes that *Nouveau système* served as a kind of "supplement and elaboration of" *Traité* and was printed together with a reissue of *Traité*. See Christensen, *Rameau and Musical Thought in the Enlightenment*, 138.

> the end of Chapter 2. From this progression the chords will be generated, and from the latter will be generated the modes, modulation and melody.[96]

We can see how the language here contrasts with the passage from *Traité* cited earlier.[97] Harmonic progression in *Traité* depended on the intervals of the fifth, fourth, third, and sixth, as these were generated by the fundamental sound and could easily be represented in the division of a string. In *Nouveau système*, Rameau introduces the concept of the *corps sonore*, the intervals of which he believed were responsible for creating chords; however, the terms of the geometric progression generate modes and the "modulation" within a mode. Rather than the fundamental generating the intervals by which the bass could move, Rameau now emphasized the geometric progression as the origin of chord motion.

Having established the importance of fifths in defining the mode, Rameau then used the geometric progression to theorize the role and existence of the subdominant. In any given triple progression of chord roots related by fifth, the three consecutive terms would describe the subdominant, the tonic, and the dominant. For example, in 3 : 9 : 27, the tonic is 9, the subdominant is 3, and the dominant in 27. Defining the mode in this way gave new significance to the subdominant chord. Basing his theory of the subdominant on the geometric progression meant that Rameau had a rational justification (however arbitrary) for the existence and behaviour of the subdominant, as the ratio between it and the tonic matched that of the tonic and its dominant. For Rameau, this

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[96] "La Progression ou le progrès du Son fondamental va se découvrir dans cette Proportion continuë-Geometrique {Ut. Sol. Ré}, {1. 3. 9}, comme nous l'avons annoncé à la fin du Chapitre II. De ce progrès naître celui des Accords, et de celui-ci naîtront les *Modes*, la *Modulation*, et la *Mélodie*." Rameau, *Nouveau système*, 29; Chandler, "Rameau's *Nouveau système,*" 247-49.

[97] See pages 151, footnote 86.

logic was sufficient proof that the subdominant had the same rational basis he used for his earlier theory of the major triad. In *Nouveau système*, he clearly saw the geometric progression as a way to rationally explain his revised theory and to tie it to geometric, Cartesian, principles.

Rameau's explanation of chord motion in *Nouveau système* differs from that of *Traité* in a way that reflects the new identity of fundamental chords. Unlike in his initial theory of harmonic motion, that was analogous to colliding bodies, in *Nouveau système* the tonic may pass to any chord; eventually it passes to the dominant, which "desires" to return to the tonic:

> If the most perfect progression of the fundamental sound is in passing to its fifth above at the beginning, the most perfect progression of this fifth must be to return to the fundamental sound, thus finishing it. Upon returning as in this case to its source,…one has nothing else to desire.[98]

Rameau writes similarly in another passage,

> The numbers {Ut. Sol. Ut.}, [2 : 3 : 4] expose the most natural progression of the principal sound, 2, which is to pass to its fifth above, 3; and that of this fifth, 3, which is to return to its principal sound, 2 or 4 [tonic]. From this arises, by imitation, the passage of the principal sound to its fifth below, and the passage of this fifth to its principal sound: in which consists all the fundamental progressions in a single mode.[99]

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[98] "Si le plus parfait progrès du Son fondamental est de passer à sa Quinte au-dessus en debutant; celui de cette Quinte doit être de retourner à ce Son fondamental en finissant; car retournant pour lors comme à sa source, on n'a plus rien à desirer." Ibid., 30; Chandler, 248-49. Here I have omitted a short phrase that Chandler added to the original. I have only included his translation of the original French.

[99] "Ces nombres {Ut. Sol. Ut}, {2. 3. 4}, exposent le plus naturel progrès du *Son principal* 2., qui est de passer à sa Quinte au-dessus 3. Et celui de cette Quinte 3., qui est de retourner au *Son principal* 2. ou 4. : de-là naissent, par imitation, le passage du *Son principal* à sa Quinte au-dessous, et le passage de cette Quinte au *Son principal*: en quoy consistent tous les progrès foundamentaux dans un même *Mode*." Ibid., 32; Chandler, 254-55.

Thus, motion from the tonic to the subdominant and back is permitted.[100] The seventh no longer serves as the agent of harmonic motion; rather, harmonies "desire" to return to the tonic. In *Traité*, the chord whose root lay a fifth below the tonic could progress to the tonic only in an irregular cadence.[101] Here, however, Rameau no longer labels this movement as "irregular," as the subdominant has been elevated to be an essential chord.

The most significant difference between *Traité* and *Nouveau système* is Rameau's new attitude toward experimental science. Here we can see the beginning of a shift in his philosophical perspective that took hold in the 1730s. In the first chapter of *Nouveau système*, Rameau describes experiments, originally conducted by Marin Mersenne (1588-1648), that are meant to prove everything he will argue in this treatise. He begins the chapter:

> A single string causes all the consonances to sound, among which, principally, is distinguished the twelfth and the seventeenth. Anyone capable of discerning these consonances may be assured of this by plucking one of the lower strings of the clavecin or by bowing the largest string on a violoncello. Thus, we believe we are able to propose this experiment as a fact which will serve us as the principle in order to establish all our conclusions.[102]

Here, he tells the reader how his principle can be proven and says that anyone can reach the same conclusions, if they do not take his word for it. In *Nouveau système*, there is no assumption that the reader is in fact likely to perform the experiment. Experiments are

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[100] Ibid., 28; Chandler, 244.

[101] Rameau, *Traité de l'harmonie*, 64-67; Gossett, trans., *Treatise on Harmony*, 75-81.

[102] "Une seule Corde fait rèsonner toutes les consonances, entre lesquelles on distingue principlaement la *Douziéme* et la *Dix-septiéme majeure*; comme toute personne capable de discerner ces Consonances pourra s'en assurer, en pinçant l'une des plus basses Cordes d'un Clavecin, ou en raclant la plus grosse Corde d'un *Violoncello*. Ainsi nous croyons pouvoir proposer cette Experience comme un fait qui nous servira de principe pour établir toutes nos Consequences." Rameau, *Nouveau système*, 17; Chandler, "Rameau's *Nouveau système,*" 213.

meant to serve as evidence of his claims; readers are not invited to participate. Moreover, the experiments occupy only a few pages, and Rameau does not deploy the same format of proposition and corresponding experiment that we later encounter in *Génération harmonique.*

In contrast, the experiments in *Génération harmonique* are foregrounded. Rameau directs the reader of *Génération harmonique* to perform certain tasks, appropriating the proposition-experiment format also found in Newton's *Opticks* and other experimental works of the time. He specifically instructs the reader on how to listen, which strings to pluck, and which organ pipes to choose from, and he tells them what to expect when they perform these operations. To observe the growth in importance of experimental routine between 1726 and 1737, we might compare the following two passages dealing with the organ. In *Nouveau système* Rameau writes:

> The same consonances may be distinguished on the organ in one of the larger *bourdon* pipes. By just blowing into one of these pipes one will hear at least the twelfth almost as distinctly as the dominating sound.[103]

In a similar but lengthier organ experiment in *Génération harmonique* we find:

> Experiment 4. Take the organ stops called *Bourdon*, *Prestant*, or *Flute*, *Nazard*, and *Tierce*, which form among themselves the octave, twelfth, and major seventeenth of the Bourdon, in ratios of 1, 1/2, 1/3, 1/5. Press one key while only the *Bourdon* is sounding, and pull each of the other stops in succession. You will hear their sounds become mixed, in succession, with one another. You will even be able to distinguish one stop from another while they sound together. But if, to distract yourself, you improvise for a moment, on the same keyboard, while all these stops sound together, and then come back to the original single key, you will no longer hear more than a single sound, which will be that of the *Bourdon*, the

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[103] "On distinguera les mêmes Consonances sur l'Orgue dans un des gros Tuyaux de *Bourdon*: et en soufflant même dans l'un de ces Tuyaux, on y entendra au moins la *Douziéme* presqu'aussi distinctement que le Son dominant." Ibid., 17; Chandler, 212.

> lowest of all, the fundamental, the sound which corresponds to the sound of the total body.[104]

These experiments are not meant to produce exactly the same results. Yet we can see the greater emphasis Rameau gives the experiments in *Génération harmonique* and the significant detail with which he describes them. In *Nouveau système*, however, he focuses principally on the results of the experiments and does not explain their operation in detail. Given the popularity of French Newtonianism in the 1730s, we can speculate that Rameau had more to gain from incorporating experiments more fully in *Génération harmonique* than he had in *Nouveau système*

The differences between *Nouveau système* and *Génération harmonique* highlight Rameau's interest in new scientific methods and increasing indifference to Cartesian mechanics. But it is important to remember that, even though he revised his theory as he became acquainted with new scientific theories, *Génération harmonique* still betrays some Cartesian characteristics. According to Deborah Hayes, Rameau's continued recourse to first principles was undeniably Cartesian.[105] She adds that Rameau diagrams the diatonic octave as a circle, as Descartes had.[106] Still, Rameau's new interest in empirical science, and perhaps Newtonianism itself, distinguishes *Génération*

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[104] "Prenez les Jeux de l'Orgue qu'on appellee *Bourdon*, *Prestant*, ou *Flute*, *Nazard* et *Tierce*, et qui forment entr'eux l'Octave, la Douziéme et la Dix-septiéme majeure du *Bourdon*, en rapports de 1, 1/2 , 1/3, 1/5; enfoncez une Touche pendent que le seul Bourdon résonne, et tirez successivement chacun des autres jeux; vous entendrez leurs Sons se mêler sucessivement les uns avec les autres, vous pourrez mêmes les distinguer les uns des autres pendent qu'ils seront ensemble: mais si, pour vous en distraire, vous Préludez un moment sur le même Clavier, pendant que tous ces Jeux résonnent ensemble, et que voux reveniez ensuite à la seule Touche d'auparavant, vous ne croirez plus y distinguer qu'un seul Son, qui sera celui du *Bourdon*, le plus grave de tous, le fondamental, celui qui répond au Son du Corps total." Rameau, *Génération harmonique*, 13; Hayes, "Rameau's Theory of Harmonic Generation," 41.

[105] Hayes, "Rameau's Theory of Harmonic Generation," 20. See footnote 1.

[106] Ibid., 60, footnote 1.

harmonique from his earlier work. Though many of the theoretical concepts in *Génération harmonique* are similar to those of the earlier treatises, especially *Nouveau système*, Rameau's manner of presentation changed, giving his work a new, Newtonian complexion.

Certain aspects of Rameau's 1726 theory of harmonic motion reappeared with only minor changes in *Génération harmonique*. Just as he had in *Nouveau système*, Rameau used the geometric progression to theorize the harmonic boundaries of a mode. The geometric progression, however, had new implications for modulation between keys and for tonal space more broadly. Since any consecutive group of three terms in the geometric progression could serve as subdominant, tonic, and dominant, any individual term in the progression could potentially serve as a fundamental sound.[107] This facilitated easier modulation between modes. The concept of tonal space implied by the geometric progression, however, required Rameau's adoption of equal temperament in *Génération harmonique*.[108] In a certain respect, equal temperament allowed for a more homogenous harmonic system, and that homogeny was necessary for Rameau to explain modulation to distantly related keys. Perhaps in order to fend off objections to his use of equal temperament,[109] Rameau explains that equally tempered keys no longer have specific qualities because they are no longer needed in order to create musical variety; such

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[107] Chandler, "Rameau's *Nouveau système,*" 66-68.

[108] Christensen suggests that Rameau's adoption of equal temperament may also have resulted from his compositional experience. Christensen, *Rameau and Musical Thought in the Enlightenment*, 202.

[109] Rita Steblin argues that Rameau must have known that adopting equal temperament would contradict the prevailing understanding of key characteristics and that as a result Rameau sought to justify his use of equal temperament by showing its origin in natural principles. See: *A History of Key Characteristics in the Eighteenth and Early Nineteenth Centuries* (Ann Arbor: UMI Research Press, 1983), 60-61.

variety was a by-product of modulating to a greater number of keys, including distant ones.[110] Whereas in *Traité*, Rameau explains the affective associations of each key (certain keys are sweet, others express furies or tempests, etc.),[111] here Rameau denounces the need for such associations:

> Let me say that he who thinks that the different impressions he receives from the differences, caused by the current temperament, in each transposed mode, elevate his spirit and bring him to more variety, is mistaken. The taste for variety is satisfied in the intertwining of modes, and not at all in the alteration of intervals, which can only displease the ear and consequently distract it from its functions.[112]

It is unlikely that Rameau truly believed that equal temperament was in use by most practicing musicians or that the alterations in equal temperament would go unnoticed by contemporary listeners.[113] Further, the qualities associated with individual

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[110] Based on Rameau's contradictory comments on key characteristics in *Génération harmonique* and in his later writing, *Code de musique pratique* (1760), Steblin argues that Rameau did not oppose the general concept of key characteristics. See: Steblin, *A History of Key Characteristics in the Eighteenth and Early Nineteenth Centuries*, 104. Instead, I would argue that Rameau argues against key characteristics in *Génération harmonique* because he believes that the new concept of modulation to distant keys makes such associations unnecessary. He may still believe that these associations exist, but they are not the primary means of creating musical variety and only distract the ear.

[111] Rameau, *Traité de l'Harmonie*, 157; Gossett, *Treatise on Harmony*, 164.

[112] "Celui qui croit que les différentes impressions qu'il reçoit des differences qu'occasionne le Tempéramment en usage dans chaque Mode transpose, lui élevant le génie, et le portent à plus de variété se prend dans l'entrelacement des Modes, et nullement dans l'altération des intervales, qui ne peut que déplaire à l'Oreille, et la distraire par consequent de ses fonctions." Rameau, *Génération harmonique*, 104; Hayes, "Rameau's Theory of Harmonic Generation," 128-29.

[113] Duffin argues that these differences would have been perceptible to eighteenth-century audiences and that they are still noticeable now. See: Duffin, *How Equal Temperament Ruined Harmony (and Why You should Care)*, passim. See also: Owen H. Jorgensen, *Tuning: Containing the Perfection of Eighteenth-Century Temperament, the Lost Art of Nineteenth-Century Temperament, and the Science of Equal Temperament, Complete with Instructions for Aural and Electronic Tuning* (East Lansing: Michigan State University Press, 1991), 1-4. Jorgensen argues that Rameau and other theorists adopted equal temperament in their writings because of their philosophical ideas, not because equal temperament was in use by practical musicians during the eighteenth century.

modes persisted long after the adoption of equal temperament.[114] In spite of this, adopting equal temperament allowed for Rameau to imagine harmonic progressions in a broader tonal space. By adopting equal temperament and letting go of these key qualities, according to Rameau, we gain access to parts of tonal space that we did not have previously. In this temperament it became possible to modulate by enharmonically reinterpreting diminished seventh chords to distant keys.[115] Ultimately, Rameau's new conception of tonal space resulted from his interest in the geometric progression. Equal temperament merely made this new space possible.

In Castel's reviews of *Génération harmonique*, he criticizes Rameau for theorizing arbitrary harmonic relationships, their arbitrariness a by-product of their homogeneity. For instance, it becomes difficult to determine which chord is the tonic when any term of the geometric progression may serve as tonic. Rameau answered this charge of arbitrariness by turning to the fundamental bass to guide the ear and clarify the harmonies within a progression: "Then is it still the fundamental succession, and its harmony, which guides the ear? Let us have no more doubts about it; everything confirms it."[116]

While some aspects of Rameau's theory of harmonic motion remained virtually unchanged in *Génération harmonique*, others are among the most significant changes in

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[114] Steblin writes that key characteristics were still generally accepted by many musicians until at least the end of the nineteenth century. See especially her chapter "Rameau and Rousseau," in *A History of Key Characteristics in the Eighteenth and Early Nineteenth Centuries*, 59-77.

[115] Rameau, *Génération harmonique*, 151-153; Hayes, "Rameau's Theory of Harmonic Generation," 176-179.

[116] "C'est donc encore la succession fondamentale, et son Harmonie qui guide ici l'Oreille? N'en doutons plus; tout le confirme." Ibid., 87; Hayes, 112.

the treatise. Instead of the seventh impelling the progression toward resolution, or the simple desire of the subdominant and the dominant to return to the tonic, motion now results from affinities born of mutually shared chord pitches. Though the fundamental progression ideally still moves by fifth, Rameau no longer insists that every non-tonic chord carry a dissonance. The relationship between the subdominant, tonic, and dominant, however, still depends on the metaphorical force created by dissonance. He explains that the subdominant and dominant "borrow" dissonances from each other: the subdominant borrows scale degree 2 [the fifth of the dominant triad] as its dissonant pitch and the dominant takes its dissonance (scale degree 4 [the tonic of the subdominant triad]) from the subdominant. Rameau refers to this process as a "mutual lending" (*prêtent mutuel*) of pitches between the dominant and subdominant. He describes their borrowed dissonances as the source of a reciprocal power (*puissance réciproque*) that pulls them both toward each other and the tonic:

> This mutual lending between dominant and subdominant so connects them to the principal sound that they are no longer separable from it: the harmonic sound of one [fundamental], from which it has already determined the diatonic succession, obliges the other to submit to it and, as a consequence, to return to the principal sound. No longer can anything be arbitrary; the rights of natural harmony and of its succession prevail everywhere.[117]

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[117] "Ce secours mutuel que se prêtent la Dominante et la Soudominante, les lient pour lors tellement au Son principal, qu'elles ne peuvent plus s'en éloigner; le Son Harmonique de l'une, dont elle a déja déterminé la succession Diatonique, oblige l'autre à s'y soumettre, et par conséquent à retourner au Son principal: il ne peut plus y avoir d'arbitraire; le droit de l'Harmonie naturelle, et de sa succession l'emporte par-tout." Ibid., 112; Hayes, 137. Here Hayes translates "secours mutuel" as "mutual lending." A more literal translation would be "mutual assistance," but I believe the concept is unchanged by this different translation. Hayes maintains consistency in her translation by referring to both terms as "mutual lending." I have also altered other parts of the translation in order to create a more literal reading than Hayes provides.

Rameau's language here conjures imagery resembling Newtonian gravitational attraction among bodies. The dominant and subdominant are drawn to the tonic and are "obliged" to return to it.

Rameau's language also strongly resembles contemporary Newtonian theories of gravitational attraction, such as Voltaire's descriptions of the reciprocal force of gravity among bodies. Voltaire summarizes Newtonian gravitational attraction among the planets thusly:

> All these laws [of attraction], all these relations, are in fact maintained by the planets with the greatest precision; thus the force of gravity attracts all the planets toward the Sun, as it does for our own globe. Finally, the reaction of each body being proportionate to its action, it is then certain that the Earth attracts [*pèser*] in its turn the Moon, and that the Sun attracts, that each satellite of Saturn attracts and is attracted by the other four, and that all five attract and are attracted by Saturn; that the same is true for Jupiter, and that all these globes are drawn to and [reciprocally] draw upon the Sun.[118]

Both Rameau and Voltaire describe movement as caused by an external force that acts on an internal property of matter. Just as the Sun "weighs on" [*pèser*] Earth, Earth and the other planets also weigh on the Sun, drawing them toward one another. This reciprocal relationship is strikingly similar (though not identical) to Rameau's theory of mutual lending between the dominant and subdominant, which draws them both to the tonic. In both descriptions, neither planetary motion nor harmonic motion is arbitrary. A natural force controls their motion. By highlighting these similarities, I do not mean to imply that

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[118] "Toutes ces règles, tous ces rapports sont en effet gardés par les planets avec la dernière exactitude; donc le pouvoir de la gravitation fait peser toutes les planets vers le Soleil, de même que notre globe Enfin, la réaction de tout corps étant proportionelle à l'action, il demeure certain que la Terre pèse à son tour sur la Lune, et que le Soleil pèse sur l'une et sur l'autre, que chacun des satellites de Saturne pèse sur les quatre, et les quatre sur lui, tous cinq sur Saturne, Saturne sur tous; qu'il en est ainsi de Jupiter, et que tous ces globes sont attirés par le Soleil, réciproquement attiré par eux." Voltaire, *Lettres Écrits de Londres sur les Anglois et autres Sujets* (Paris, 1737), 69; Voltaire, *Lettres Philosophiques*, ed. John Leigh, trans. Prudence Steiner (Indianapolis: Hackett Publishing Company, Inc., 2007), 54. I have inserted the word "reciprocally" into the English quote above because it appears in the French version. Steiner does not include it in her translation but I believe it is significant in this discussion.

Rameau based his revised theory of harmonic motion on Voltaire's explanation of gravity. Their striking resemblance nevertheless points to the prevalence of Newtonianism more generally during the time when Rameau wrote *Génération harmonique*.[119] The revisions to Rameau's harmonic theory and its relationship to Newtonian attraction point to the larger role Newtonianism played in French intellectual culture of the 1730s and its power to shape works like Rameau's. We can see that, in addition to his use of experiments, Rameau also drew on a Newtonian language of attraction—immensely popular and controversial at the time—to revise his theory of harmonic motion. It is possible that he was not fully aware of the consequences of imitating Newtonian language in this way, or even of the extent to which his language was Newtonian. But, consciously or not, he revised his theory in a way that aligned it with Newtonian science during its most controversial decade in France.

Conclusion

From this discussion of Rameau's revisions to his harmonic theory, his critics' reactions, and his polemic with Castel, we can see how Newtonianism might have guided Rameau's thinking in *Génération harmonique*. But we can only speculate as to whether Rameau was truly familiar with Newton's works or whether gravitational attraction had gained such popularity among Parisian learned circles that Rameau was aware of it. The Newtonian culture of the time, nevertheless, offers a useful context in which to explore anew, and assess the theorist's important work.

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[119] Christensen suggests that Rameau may have encountered Newtonianism through Voltaire. See Christensen, *Rameau and Musical Thought in the Enlightenment*, 188.

We can understand Rameau's Cartesian loyalty while also exploring his attempt to appeal to the broadest possible readership. His continued application of Cartesian rationalism must have appealed to older Academy members and the intellectual establishment. But his use of terms and methods associated with Newtonianism likely would have drawn the attention of newer Academy members and Newtonians outside the Academy. The context for the publication of *Génération harmonique*, as discussed in this chapter and Chapter 3, offers a network of ideas through which we might view some of the forces that likely guided Rameau's thinking as he refashioned his harmonic theory. His heated exchanges with Castel must have alerted Rameau to the contentious terrain in which his work was to be assessed, whether he liked it or not. He was rarely reluctant to respond to criticism. Indeed, his voice became a part of the intellectual debates that Newtonianism engendered in the 1730s, however we might choose to characterize his own intellectual affiliations.

Ultimately, his voice in the debates of the time did not attract substantial scientific approbation. Though he enjoyed success as an opera composer and as a music theorist, Rameau did not acquire the public status of *musician-savant*. Historians of music theory today remember him as a groundbreaking theorist who also attempted to incorporate science into his methodology. But Rameau does not figure into the history of science. Nor was he accepted into the Academy as a consequence of his work in the 1730s. Though he likely did not consciously adopt Newtonian characteristics, reading *Génération harmonique* as a part of a larger trend among Newtonian authors is still illuminating.

In the next chapter I will discuss the general absence of Newtonianism in Rameau's later writings. Those texts may point to the fact that Rameau adopted scientific methods in the 1730s only opportunistically. On the other hand, his concepts of "reciprocal power" and the *double emploi* suggest a fundamental change in his concept of harmonic motion.

Chapter 5: After the "Newton Wars": Legacy and Conclusions

In the previous four chapters I have outlined the major components of French Newtonianism, its origin, and its key proponents. I have examined Rameau's Newtonianism and its consequences for him both socially and professionally. In Chapter 2, I discussed Rameau's relationships with major figures of French Newtonianism, including the Encyclopedists who figure prominently in this chapter. In Chapter 3, I focused on Rameau's relationship to Mairan and his possible exploitation of their friendship for his professional gain. Rameau attempted to adapt Mairan's theory of corpuscular sound and use of experiments to promote and advance his concept of the *corps sonore*. These experiments were trendy at the time and would have made Rameau's work more popular. They are also the most strikingly Newtonian aspect of his work, through which his reviewers would have connected him with Mairan and Newton. In Chapter 3, I discussed his exploitation of his relationship with Mairan as his "inside" approach to gaining professional status through an appeal for support from the Academy.

In Chapter 4, I focused on Rameau's relationship with Voltaire and his adoption of certain terms that resonated with Voltaire's explanation of Newtonian gravitational attraction. In *Génération harmonique*, Rameau borrowed terms from Newtonian physics to explain tonal motion, including the "mutual lending" of dissonance and the "reciprocal power" between the subdominant, tonic, and dominant. I also showed how Rameau's contemporaries reacted to his changing harmonic theory. His polemic with Castel serves as an example of the Cartesian reaction to certain new ideas in his work. Voltaire's defense of Rameau from Castel also would have implied that he and Rameau were on the same side of this larger ideological debate, thus associating his work with Voltaire and

distancing it from Cartesians like Castel. Rameau's reliance on terminology associated with gravitational attraction from popular scientific works like Voltaire's represents an "outside" approach to gaining social status within the intellectual public and intellectual community at large. The polemic with Castel also demonstrates specifically how Rameau became entangled with French Newtonianism, as Voltaire's essay came in the midst of an already contentious relationship with Castel. Rameau and his work provided yet another opportunity for Voltaire and Castel to continue their verbal sparring.

In this final chapter, I discuss the aftermath of the "Newton Wars" for French intellectual culture after the 1730s as Newtonian physics gained acceptance on the Continent. I will discuss what became of the central figures and institutions I have discussed thus far, including Voltaire and the Academy. I will also claim that Rameau's use of Newtonian and Cartesian scientific methods changed after the 1730s and that this change reflects Rameau's larger goal of gaining scientific and social prestige. His apparent indifference to Newtonian methods and terminology in his later theory points to the possibility that he adopted Newtonian terminology and methods in *Génération harmonique* for pragmatic rather than purely theoretical reasons, then turned away from them when they were no longer useful. In this chapter I focus on Rameau's writings after the 1730s, including the *Démonstration du principe de l'harmonie* (1750) and *Nouvelles réflexions de M. Rameau sur sa démonstration du principe de l'harmonie* (1752).

The decades after the 1730s saw Rameau attempting to foster relationships with prominent thinkers and subsequently ending those relationships. In order to sufficiently explain Rameau's activities in the 1740s and 50s, I will discuss his relationships with Jean le Rond d'Alembert, Jean-Jacques Rousseau, and Denis Diderot, three central

authors of the *Encyclopédie* (first discussed in Chapter 2). I will explain Rameau's criticisms of the musical articles in the *Encyclopédie*. Then I will discuss the changes that d'Alembert and Friedrich Wilhelm Marpurg (1718-1795) made to Rameau's theory as they began to disseminate it. As further evidence of Rameau's troubled relationships with prominent intellectuals, I also discuss Rameau's failed attempts to gain support and approval from foreign scholars, including Leonard Euler (1707-1783), Daniel Bernoulli (1700-1782), and Gabriel Cramer (1704-1752). My discussion of Rameau's legacy closes with an examination of his reputation as a "musician-savant" and his falling out with d'Alembert. Finally, I discuss possible extensions of this research to other topics and figures in the history of music theory, as well as other avenues for future research.

French Newtonianism after the 1730s

As we have seen in the previous chapters, the 1730s were an especially heated time for French Newtonianism. The government banned Voltaire's increasingly popular treatment of Newton in his *Lettres philosophiques* and the church reacted strongly to Newtonianism and the new social movements with which it was connected. As we saw in Chapter 3, science had taken the place of philosophy as the most fashionable leisure activity among the educated elite. By the 1740s, however, the controversy surrounding French Newtonianism had abated. Certainly by the time of the *Encyclopédie*, Newtonian physics was more or less accepted by the French intellectual establishment. Shank identifies several circumstances leading to this acceptance.

Among the most significant factors in the acceptance of French Newtonianism was the increasing importance of the work of mathematician Gottfried Wilhelm Leibniz

(1646-1716) in the 1740s. His work complicated the "Cartesian versus Newtonian" binary that had developed during the previous decade.[1] He sought to develop the concept of *vis viva*, which centered on the idea of a living force inside of matter that caused it to move. Though the scientific underpinnings of gravitational attraction and *vis viva* differed, the two concepts were similar in that they were both theories of mechanics, and the causes of both were unknown. For this reason, both concepts were polarizing among Cartesian and Newtonian scientists.[2] Leibniz did not approve of Newtonian gravitational attraction, and his position created fodder for other anti-Newtonians in France. Cartesians, for example, seized on Leibniz's statements that gravitational attraction could not be valid because it lacked rigorous mathematical mechanics.[3] However, *vis viva* was also considered to be similar to gravitational attraction, as it carried the same natural and material implications and was thought to encourage a certain Spinozist pantheism. As the popular reputation of Leibnizian *vis viva* took on a reputation for having the same controversial, occult characteristics as gravitational attraction, Newtonianism became less controversial. In part because of the increasing interest in and disagreements over *vis viva*, by the 1740s, Newtonian gravitational attraction was perceived to be much less radical than it had been a decade earlier.[4]

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[1] For more on Leibniz's relationship with Newton, Newtonians, and Cartesians, see Catherine Wilson, "The Reception of Leibniz in the Eighteenth Century," in *The Cambridge Companion to Leibniz*, ed. Nicolas Jolley (Cambridge: Cambridge University Press, 1995), 442-474; see also Shank, *The Newton Wars and the Beginning of the French Enlightenment*, 426-427.

[2] Ibid., 426.

[3] Shank, *The Newton Wars*, 214 and 426-7.

[4] Ibid., 458.

Further affecting cultural attitudes toward Newtonianism was the younger generation of mathematicians, which included d'Alembert and Alexis-Claude Clairaut (1713-1765). Both dealt with issues of Newtonian celestial mechanics from a mathematical perspective that was thought to give gravitational attraction a more sound foundation. Like Maupertuis, discussed in Chapter 2, Clairaut was concerned with the shape of the Earth, while d'Alembert focused on the mathematics of attraction and treated the bodies in question as mathematical entities. D'Alembert's analysis was not concerned with the ontologies of the physical bodies themselves. By focusing his attention on the movement of bodies instead of their physical make up, he effectively deflected attention away from the more metaphysical problems associated with attraction.[5]

Shank emphasizes that, while neither d'Alembert nor Clairaut were widely read, due to the specialized nature of their texts, both were heralded in the press. And as both were members of the Academy, their explanations of Newtonian physics were considered more valid than that of Voltaire. The overall effect was the public impression that gravitational attraction was more soundly rooted in physics than it had been at the start of the eighteenth century, and that the Academy had accepted the science of attraction. Even though the cause of gravity remained unknown, its existence was widely accepted in the Academy by 1745. It was considered a "fact of nature proven by experience."[6]

Changes in Academy membership also affected the new general acceptance of Newtonianism. Fontenelle, who had opposed the Newtonian efforts of various Academy members, retired in 1740 and died in 1757. He published a final defense of Cartesian

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[5] Ibid., 457-58.

[6] Ibid., 458.

vortices just before his death.[7] Shank argues that despite the complexity of Fontenelle's interests, this final publication significantly shaped his legacy and placed him on the wrong side of history, in opposition to Newtonian gravity.[8] Mairan, who as we have seen was a lifelong supporter of Cartesian physics, also retired in 1743. Maupertuis, the most prominent initial supporter of Newton in the Academy, passed away in 1759. The majority of those left were Newtonians who had not participated in the controversies of the previous generation. In 1758 d'Alembert observed that Cartesians were "a sect, in truth, very much diminished today."[9]

Shifts in journalistic practice furthered the new acceptance of Newtonianism. The *Journal des Sçavans* took on new editors during this period, and other journalistic writing appeared that more explicitly supported the work of new Academicians.[10] The *Journal de Trévoux* also went through a period of change when Castel was removed from his editorship in 1745. He continued to publically oppose Newtonianism and even published a treatise in 1743, *Le vrai système de physique generale de M. Isaac Newton*, in which he

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[7] Bernard le Bovier de Fontenelle, *La théorie des Tourbillons Cartésiens* (Paris: Hippolyte-Louis Guerin, 1752).

[8] Ibid., 468. Shank also refers readers to his article on Fontenelle's relationship with Cartesianism, "On the Alleged Cartesianism of Fontenelle," *Archives Internationales d'Histoire des Sciences* 53, nos. 150-51 (2003): 139-56.

[9] "…Secte à la vérité fort affoiblie ajourd'hui…" Jean le Rond d'Alembert, *Traité de dynamique,* 2nd ed. (Paris, 1758), vi. As quoted in Shank, *The Newton Wars*, 465. My translation.

[10] See for example the writings of Guillaume Thomas Raynal, *Nouvelles littéraires* beginning in 1744.

claimed to "expose" Newtonian science.[11] Around this time he somehow offended the Jesuit authorities, who decided to replace him as editor of the *Trévoux*.[12]

The most significant aspect of Newtonian acceptance is that by 1750 the French Newtonians had become more unified as a group than they were in the 1730s. Even so, they were still primarily defined by their opposition to other scientific perspectives.[13] Nevertheless, the increasing interest in Leibniz's work and the associations between Leibniz and religious controversy meant that Newtonianism was no longer seen as the primary scientific enemy of the Church.[14] The new, more mathematical version of French Newtonianism was considered less metaphysical and more grounded in the well-respected work of d'Alembert and Clairaut. In this form, Newtonianism posed less of a threat to religious authority. Shank argues that the acceptance of Newtonianism during the 1750s coincided with the consolidation of the French Enlightenment more generally. He points to the *Encyclopédie* as the biggest reason for this consolidation.[15]

Voltaire after the 1730s

Following the hostile reception of *Lettres philosophiques* (1734) from the state authorities, Voltaire kept a relatively low profile for the remainder of the 1730s. Voltaire

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[11] Shank, *The Newton Wars*, 466.

[12] John N. Pappas, *Berthier's* Journal de Trévoux *and the* Philosophes. Studies on Voltaire and the Eighteenth Century, vol. 3 (Geneva: Institute and muse Voltaire, 1957), 18-35. As cited in Shank, *The Newton Wars*, 466. Shank notes that the specific reasons for Castel's removal remain unclear.

[13] Shank, *The Newton Wars*, 469.

[14] Ibid., 470. Shank points to *Astronomie physicae juxta Newtonis principia breviarum* (Paris, 1748) by Pierre Signorgne in which the author endorsed Newtonianism while holding a church-sanctioned chair at the University of Paris. This work serves as evidence that the Church no longer saw Newtonianism as a threat as it previously had.

[15] Ibid., 481.

seemed aware that his situation was more perilous after he fled Paris in 1734 than it had been previously. In 1738 he published *Éléments de la philosophie de Neuton*, which also drew mixed reactions. Castel, surprisingly, at first gave the text a good review, which can be seen as a brief attempt on his part to be publically associated with Voltaire, a reversal of his position just a few years earlier during the polemic with Rameau. Shank writes, "Castel also placed himself with Voltaire atop the intellectual pedestal above the small-minded savants who saw in the 'Voltaire phenomenon' something dangerous and suspect."[16] During this time, nearing the end of his tenure as editor of *Journal de Trévoux*, Castel may have briefly taken to the idea of being outside the institutional group of intellectuals.

Castel's positive review of Voltaire's *Éléments* is especially striking because of his exchange with Voltaire just a few months earlier. Voltaire had sent Castel some materials before the official publication, and Castel responded harshly to them in print.[17] His later praise for the work was no doubt helpful to Voltaire, as it came from the official Jesuit journal at a time when Voltaire's relationship with the Church establishment was still unstable. In Castel's negative and positive responses, we can see that his stance regarding Newtonianism was a complicated one. Despite the insulting nature of Voltaire's comments in the polemic I discussed in Chapter 4, Castel ultimately supported

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[16] Shank, *The Newton Wars*, 380.

[17] Voltaire refers to Castel's negative commentary in a letter to Maupertuis. Voltaire [François Marie Arouet], "*Voltaire [François Marie Arouet] to Pierre Louis Moreau de Maupertuis: c. Sunday, 15 June 1738 — [letter]*," In *Electronic Enlightenment*, edited by Robert McNamee et al. University of Oxford. <http://www.e-enlightenment.com.proxy1.lib.uwo.ca/item/voltfrVF0890146b_1key001cor/>, accessed August 14, 2014. However, the commentary Voltaire refers to is unknown. In a footnote in the above source, Theodore Besterman notes that he was unable to find Castel's criticism that Voltaire describes. Shank cites this letter in *The Newton Wars*, 380.

many of Voltaire's endeavours just a short time later. Shank notes that Castel and the Jesuits sided with Voltaire, Maupertuis, and the Newtonians on some issues, and with Mairan, Fontenelle, and the Cartesians on others.[18]

Despite the controversy surrounding Voltaire's *Lettres philosophiques* and the mixed reactions to *Éléments*, we can see that by the 1740s he became generally regarded as a philosophe. His ability to solicit public support and to project authority over scientific and philosophical issues marks the ultimate difference between Voltaire's and Rameau's quests for recognition. The composer-theorist sought and commanded support from the public, but he seemed to view the Academy as an indispensible source of prestige and stability for his work and reputation. Voltaire, however, did not seem to view institutional support as the best channel for his success.

By the 1750s certain similarities between Voltaire and Rameau began to emerge, despite the fact that Rameau was never exiled and enjoyed relative personal stability compared to Voltaire. Both sought status in academies at different points, and both were rejected.[19] Neither Rameau nor Voltaire is primarily remembered as a scientist or philosopher. Among musicians and music scholars, Rameau is remembered as a composer-theorist (and for many musicians today his reputation as a composer far outshines his theoretical works). Voltaire is more famously remembered as a playwright and satirist than as a scientist. Yet both men received some recognition in their lifetimes for their use and study of science. To deepen the comparison, it is necessary to discuss Rameau's activities after the 1730s.

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[18] Ibid., 404.

[19] Voltaire attempted to obtain a seat in the *Académie française* in the 1740s but it was given to Mairan instead. See Shank, *The Newton Wars*, 476-47.

Rameau after the 1730s

In addition to the success of his theoretical treatises, Rameau enjoyed great success as an operatic composer from the 1730s onward. In the 1750s, he became embroiled in a debate that pitted his operas against those of Lully, but Roger Lee Briscoe writes that Rameau did not seem to relish the opportunity to argue publically about his operas as he did about his theories.[20] Briscoe also points to Rameau's group of influential friends during the 1730s and '40s, including Voltaire (though exiled), Madame Pompadour (the King's advisor and mistress), La Pouplinière, and Count d'Argenson (Secretary of State).[21] These connections confirm that his political situation was not especially tenuous, as he had the support of a wealthy patron, the King's aid, and the Secretary of State.

Newtonianism did not figure into Rameau's theories or the reception of his work in the 1750s. In this decade, Rameau disassociated himself from the Newtonians by removing the most identifiably Newtonian aspects of his theory. Rameau was awarded a modest pension from the government in 1745 and the title of Composer of the King's Cabinet; he received another pension from the Royal Opera in 1750.[22] From this government support and his operatic achievements, we can conclude that he enjoyed as much or more financial success than any composer or musician in France at the time. Nevertheless, he continued to seek Academy membership. Given his existing pensions

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[20] Roger Lee Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions de M. Rameau sur sa démonstration du principe de l'harmonie*, 6-9.

[21] Ibid., 9.

[22] Ibid., 9.

and other income, it is reasonable to assume that Rameau wanted to be an Academy member because of the social prestige it would have lent him and his work. Academy membership would have meant that his work was officially sanctioned by the monarchy and would have ensured his legacy as a music theorist and philosophe.

Briscoe discusses Rameau's attempts to gain intellectual status:

> In spite of the success of his compositions, Rameau must have wished even more for his acceptance as a *philosophe*, that is, as a scientist of music rather than "merely" as an artist. This was a higher quest for the true Enlightenment man. His *Génération harmonique* of 1737 had been dedicated to the Royal Academy in an apparent attempt to gain Academy membership. A little over ten years later he tried again with the paper that would become his *Démonstration*.[23]

Even though the Academy had given its approval of *Génération harmonique*, he continued to seek its acceptance in the 1750s.

While Rameau continued to solicit approval for his work from the Academy in Paris, he also sought approval from scientists abroad, such as Bernoulli and Euler.[24] He also wrote to prominent Italian scientists such as Giovanni Poleni (c.1683-1761) in Padua, and Jacopo Bartolomeo Beccari (1682-1766) and Padre Martini (1706-1784) in Bologna. To Bernoulli and Euler he sent advance copies of *Démonstration* and *Nouvelles réflexions* to obtain their support before publishing them in France.[25] Briscoe writes, "Perhaps Rameau felt that these philosophers could assist him in his aspiration for admittance to the Academy."[26] From these letters to scientists and mathematicians in

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[23] Ibid., 10.

[24] Ibid., 11.

[25] Ibid., 59.

[26] Ibid., 76.

other countries we can see that Rameau continued to seek acceptance from the scientific community.

Rameau may have been driven to seek outside support because of the increasingly embattled nature of his relationships with French thinkers such as d'Alembert, Diderot, and Rousseau. His criticisms of the music articles of the *Encyclopédie* in 1755-1757 created new tension with these men.[27] Adding fuel to the fire, reviewers of *Démonstration* questioned whether Rameau had truly "demonstrated" anything in a scientific sense. The Academy had approved of his original text, which he presented at an Academy meeting in 1749 with the title of "Memoires,"[28] but members reacted negatively when Rameau changed both the title and some aspects of the text, which was then published as his *Démonstration*.

Rameau's writing in *Démonstration* is generally considered to be better than in his earlier treatises, and the improvement suggests that he may have received assistance from another author. Briscoe considers the possibility that Diderot helped Rameau prepare this document for publication. Though some primary source evidence in letters does indicate Diderot's involvement, Briscoe is sceptical. He points out that Rameau never cites Diderot directly so it is difficult to be sure.[29] However, as I have discussed previously, Rameau did not always provide citations for authors he read, such as Descartes.

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[27] Ibid., 12.

[28] See Christensen, *Rameau and Musical Thought in the Enlightenment*, 159-61, for more on the origin of this material that Rameau presented at the Academy and that later became the *Démonstration*.

[29] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 17-18.

The years between *Génération harmonique* in 1737 and *Démonstration* in 1750 constitute the longest gap between consecutive theoretical works of Rameau. Briscoe suggests that Rameau's increased compositional activity was the reason for this hiatus.[30] Eventually, Briscoe writes, Rameau returned to his theories of music in order to "take his place among the philosophes as a mathematician-scientist."[31] Briscoe says of Rameau's *Démonstration*:

> The most respected and successful musician in all France is trying to convince the Royal Academy of Sciences that he is not 'merely' an artist, but worthy of membership as a *philosophe*; that music is an art given by nature, but its principle is the source of mathematics as well.[32]

Near the end of *Démonstration* Rameau makes the case again that his endeavours were not just artistic:

> I shall only tell you, gentlemen, in regard to the practice of music, that when I devoted myself to it while working in the theater, if I was carried away by the pleasure of making, like an artist, many paintings for which I had conceived the idea (something which infinitely inflates the taste and imagination), I was even more inflated by the idea of seeing, like a philosopher, the game of all these phenomena, whose source [*principe*] was no longer unknown to me, and of producing an infinity of effects whose cause I was placed in a position of perceiving.[33]

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[30] Ibid., 14. For more on Rameau's later years see Christensen, *Rameau and Musical Thought in the Enlightenment*, especially Chapter 10, "The Final Years," 291-306. See also Cuthbert Girdlestone, *Jean-Philippe Rameau: His Life and Work*, especially Chapter 10, "Life: The Last Thirty Years," 475-518.

[31] Ibid.

[32] Ibid., 49-50.

[33] "Je vous dirai seulement, Messieurs, à l'égard de la pratique, que lorsque je m'y livrai en travaillant pour le Théâtre, si je fus entraîné par le plaisir d'y faire, comme Artiste, beaucoup de peintures dont j'avois conçû l'idée, chose qui flate infiniment le gout et l'imagination, je le fus encore davantage par celui de voir, comme Philosophe, le jeu de tous ces phénoménes, don't le principe ne m'étoit plus inconnu, et de donner lieu à une infinite d'effets dont je m'étois mis en état de connoître les causes." Jean-Philippe Rameau, *Démonstration du principe de l'harmonie* (Durand: 1750), 111-12; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 183. All the French translations in this chapter are Briscoe's.

Rameau wanted the Academy members to know that he was not satisfied with artistic creation alone, but that he needed to understand the principle that guided such creativity. He believed that he was capable of understanding the source of music, in addition to composing music.

A comparison of *Démonstration* to *Génération harmonique* shows that the music-theoretical content of *Démonstration* is similar to that of *Génération harmonique* but the Newtonian aspects are conspicuously absent. *Démonstration* contains none of the experiments that were so prominent in the earlier treatise. Neither does he use the Newtonian language of "mutual lending" or "reciprocal power" to explain the subdominant and the *double emploi* as he did in *Génération harmonique*. Rameau also places less importance on his concept of the "Ear" that embodied experiential knowledge in his earlier work. Briscoe writes that *Démonstration* is less practical than Books 2 and 3 of the *Traité*.[34] Briscoe clearly sees this bid for Academy recognition as different from his earlier attempts. He writes, "It is probable that the attempt by Rameau to present an even more scientific and mathematical 'demonstration' of his theories represents a goal which would itself dictate a change in style from the earlier treatises."[35]

The most notable contrast between *Démonstration* and the earlier treatises is the lack of practical information for musical performance. We can also observe some changes in the presentation of theoretical concepts. Briscoe believes Rameau's clearest explanation of the *double emploi* appears in this document: "That A may be considered

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[34] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 19.

[35] Ibid.

the fifth of D or the third of F."[36] In other words, in the chord D-F-A-C, the pitch A may serve as either the fifth or the third, depending on whether D or F serves as the root. This explanation shifts our attention away from the "reciprocal power" of the dissonances that define this chord. Here, Rameau does not explain the *double emploi* in terms of "mutual lending" as he did in *Génération harmonique*. He simply says that he has fully explained the concept elsewhere and moves on.[37] While for Rameau this may have been a simple alteration to his theory, explaining the *double emploi* this way is a significant reconceptualization of his theory. His new explanation demonstrates that reciprocity among dissonances no longer defined the *double emploi*, meaning dissonance was no longer the primary agent of chord motion.

In *Démonstration*, Rameau also provides a slightly altered theory of the minor triad and continues to justify his use of equal temperament.[38] Though this document is less empirically driven, Rameau still uses Nature as a point of departure, as he had in *Génération harmonique*.[39] Most significantly, we see Rameau criticize the reliability of experience in *Démonstration*:

> Experience, and the rules which it dictates, is a long and perplexing journey; a method which does not produce anything except very slowly and one with which one could not be at all sure of having anything; a method which only clarifies in

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[36] "que le *la*, dont il y est question, appartienne à *fa* 3, comme *Tierce*, ou à *ré* 81, comme *Quinte*." Rameau, *Démonstration*, 58-59; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 151. It could be said that this is not necessarily the clearest explanation of the *double emploi*, but it is the most succinct.

[37] Jean-Philippe Rameau, *Nouvelles réflexions de M. Rameau sur sa démonstration du principe de l'harmonie* (Paris: Durand, 1752), 27; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 227.

[38] For the details of the new theory of the minor triad, see Rameau, *Démonstration*, 29-30; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 130.

[39] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 29.

> one particular case at a time, and by which indications can scarcely be generalized without giving many of them haphazardly, and exposing them to errors — experience, I repeat, was the resource of the ancients.[40]

Rameau says that "the moderns" have not used experience much better than the ancients.

Despite Rameau's criticisms of experience, empirical observation still plays a prominent role in *Démonstration*. In this treatise, we can observe an increase in tension between reason and experience. While Rameau questions the value of experience, he emphasizes its importance in his descriptions of hearing the *corps sonore* for the first time. Rameau imagines himself as a *tabula rasa*: "I placed myself, therefore, as exactly as was possible in the position of a man who would neither have sung nor have heard singing…"[41] He continues depicting this scenario in which he searches in Nature for that sonic axiom which he could not find within himself. Rameau describes hearing his first sound:

> My search was not long. The first sound that struck my ear was a flash of lightening. I perceived, suddenly, that it was not a single [sound] for it made the impression on me that it was a composite [sound]. There, I immediately said to myself, is the difference between noise and [musical] sound.[42]

In Rameau's comparison between hearing the *corps sonore* and experiencing a flash of lightening, we can see the material significance Rameau ascribes to the *corps sonore*.

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[40] "L'expérience et les regles qu'elle dicte, voie longue et perplèxe, méthode qui ne donne les choses que très-lentement, avec laquelle on n'est point sûr de les avoir toutes, qui n'éclaire jamais que sur un cas particulier à la fois, et don't on ne peut guéres generaliser les indications, sans donner beaucoup au hazard, et s'exposer à des erreurs, l'expérience, dis-je, fut la ressource des Anciens." Rameau, *Démonstration*, 4-5; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 113-14.

[41] "Je me plaçai donc le plus exactement qu'il me fut possible dans l'état d'un homme qui nauroit ni chanté, ni entendu du chant…" Rameau, *Démonstration*, 11; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 118.

[42] "Ma recherche ne fut pas longue. Le premier son qui frappa mon oreille fut un trait de lumiere. Je m'apperçus tout d'un coup qu'il n'étoit pas un, ou que l'impression qu'il faisoit sur moi étoit composée; voilà, me dis-je sur le champ, la différence du *bruit* et du *son*." Rameau, *Démonstration*, 12; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 118-19.

Though he emphasizes the rational aspects of his theory in this treatise, experience is still crucial to musical understanding. It is worth noting that, although Rameau seems to be talking in Lockean terms here, his use of the phrase "flash of lightening" (*le coup de foudre*) is redolent of Descartes and his revelation that reason was the foundation of knowledge.[43]

Further emphasizing rationalism in his theory, Rameau expands his use of the geometric progression in *Démonstration*. In *Génération harmonique* Rameau used the geometric triple progression to theorize the relationship between the subdominant, tonic, and dominant. Terms in the series related by 3, such as [3 : 9 : 27], could correspond to a series of pitches related by fifth, such as [F : C : G] (see Plate 2 below for a facsimile of Rameau's diagram). In *Démonstration*, Rameau extends this concept so that each group of three terms could constitute one term of a higher-level progression:

[1 : 3 : 9] [3 : 9 : 27] [9 : 27 : 81]

[B-flat : **F** : C] [F : **C** : G] [C : **G** : D]

In each bracketed group, one "generative" pitch serves as the primary pitch situated between its subdominant and dominant. The three groups of terms together illustrate the relationship between keys that are closely related (F, C, and G).[44] In this way Rameau expanded on the most mathematical aspects of his earlier work (temperament, ratios, and the geometric progression) in a way that would have appealed to the Academy's membership. Rameau's diagram illustrates that he was grappling with how to represent

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[43] René Descartes, *Discourse on Method*, trans. Laurence J. Lafleur (New york: Liberal Arts Press, 1950), 22-35; as cited in Bruce Mazlish, *The Fourth Discontinuity: The Co-Evolution of Humans and Machines* (New Haven: Yale University, 1995), 22, footnotes 14-16.

[44] Rameau, *Démonstration*, 41-44; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 140-41.

both chords and keys as distinct levels of pitch space. From this representation of chords and modes we can see that Rameau furthered his conception of spatial musical relationships that he initially began in *Génération harmonique*. While in 1737 he only discussed the subdominant, dominant, and tonic in spatial terms, here he conceives of higher-level, key relationships in a new spatial configuration. There is not space to address this idea more fully here, but it is an issue I hope to explore in future work.

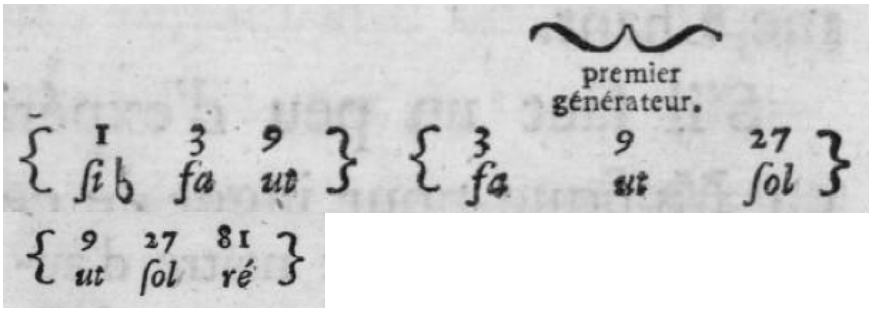

Plate 3. Rameau's higher-level progression from *Démonstration*, p. 42. The three progressions that make up this higher-level progression were originally printed on different lines of text. I have attempted to align them here.

Though the Academy approved of the "Mémoire" document that Rameau presented, he evidently took their approval too far by publishing it under the *Démonstration* title. Reviews of the treatise, while mostly positive, were somewhat mixed because of this issue. In a later response to Rameau's *Erreurs dans l'Encyclopédie* (which I discuss later), d'Alembert stated that Rameau's theory could not truly be called

a "demonstration."[45] Briscoe states that *Démonstration* received many positive reviews because the Academy had previously issued an approving report on the version of it that Rameau presented. Briscoe also discusses an essay by Pierre Estève (1720-1779), in which he criticized Rameau's *Démonstration,* focusing especially on the identity of octaves and the concept of the major triad as a natural phenomenon.[46] Like d'Alembert, Estève had difficulty accepting Rameau's treatise as an actual "demonstration."[47]

Rameau's *Nouvelles réflexions* (1752) can be considered a response to the criticisms of his earlier work. The first chapter clearly draws on much of his work in *Démonstration***,** including a rational discussion of musical intervals and the *corps sonore* as well as the Ear's ability to hear the differences in musical temperament. Rameau also intended this treatise to establish the applicability of the principle of the *corps sonore* to other disciplines. He writes:

> What fecundity in this phenomenon, what consequences that may not be deducted from themselves? Can we deprive ourselves of looking upon a phenomenon so unique, so abundant, so well-reasoned, if I may use this term, as a principle common to all the arts in general, at least to all the arts of good taste.
>
> In fact, is it not reasonable to think that Nature alone, however we know it to be in its general laws, would have only one source [*principe*] for all things which seem to be so closely related to each other, and that nature excites in us nearly the same sensations as the feeling of beauty which the arts are destined to give us?[48]

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[45] Jean le Rond d'Alembert, "Avertissement des éditeurs," *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, (Paris, 1751-1780; repr., Stuttgart-Bad: Cannstatt, Frommann, 1966), vol. VI, 1-2; reprinted in Erwin Jacobi, *CTW* vol. V, 289-290.

[46] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 54. See See Pierre Estève, *Nouvelles découverte du principe de l'harmonie avec un examen de ce que M. Rameau a publié sous le titre de Démonstration*…(Paris: Huart et Moreau fils, Durand, 1751).

[47] Ibid.

[48] "Que de fécondité dans ce phœnomène, que de conséquences ne s'en déduisent pas d'elles-mêmes? Peut-on se refuser de regarder un phœnomène aussi unique, aussi abondant, aussi raisoné, si je puis me servir de ce terme, comme un principe commun à tous les Arts en général, du moins à tous les Arts de goût.

Rameau discusses other disciplines, such as architecture, where he believes the *corps sonore* is intimately foundational. He refers frequently to the work of Charles-Étienne Briseux, a prominent Parisian architect with whom he had contact.[49] Briscoe writes that, absurd as it may seem, Rameau's attempt to apply the *corps sonore* to other disciplines was typical in its generalizing impulse.[50] Rameau's attempt to apply the *corps sonore* in this way was in keeping with eighteenth-century beliefs in the interrelationship between the mimetic arts.[51]

While arguing for the primacy of his principle of the *corps sonore* in *Nouvelles réflexions*, Rameau references Newton for the first and only time in his theoretical works. He writes:

> If Newton, for example, had known this principle, would he have chosen a diatonic system, a system of simple products besides [being] full of errors, in order to compare it with colors? Would he not have examined beforehand to see if these colors ought not be considered as each forming a base, a generator, and as forming themselves into groups, an agreeable assemblage? Would he not have chosen, first of all, those which may be compared with octaves and fifths? After having recognized the superiority of these fifths in harmony and in its succession, he would have undoubtedly acted accordingly.[52]

En effet, n'est-il pas raisonable de penser que la nature simple, comme on fait qu'elle l'est dans les loix générales, n'auroit qu'un même principe pour toutes les choses qui semblent avoir tant de rapport entr'elles, en excitant en nous à-peu-près les mêmes sensations, telles que sont les Arts destinés à nous donner le sentiment du beau." Rameau, *Nouvelles Réflexions,* 61-62; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 246. I have slightly altered this translation from Briscoe's.

[49] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 52.

[50] Ibid., 70.

[51] Ibid.

[52] "Si M. Newton, par example, eût connu ce principe, auroit-il choisi un système diatonique, système de simples produits, d'ailleurs plein d'erreurs, pour le comparer aux couleurs? N'auroit-il pas examine auparavant si ces couleurs ne devoient pas être considérées comme formant chacune une base, un générateur, et comme formant entr'elles des groupes, un assemblage agréable? N'y auroit-il pas choisi

Here Rameau refers to Newton's theory of colors and the suggested connection between the color spectrum and the diatonic scale. Briscoe describes Rameau's statement:

> The parallel between colors and music is rather questionable and probably the mention here of Newton by Rameau was more a matter of paying homage to one of the most respected scientists of his time than offering a valid criticism of Newton's theories or methods.[53]

While Briscoe is right to point out Newton's problematic equation of the diatonic scale and the colour spectrum, I disagree with his interpretation of Rameau's motivation for mentioning Newton. I believe that Rameau mentioned Newton in this way neither in order to pay homage, nor to criticize his theory of colors and music. Rameau likely knew that Newton's comparison of pitch and color was flawed. But Rameau's suggestion that Newton would have acted differently if he had known the corps sonore is striking. For Rameau, stating that Newton would have used the *corps sonore*, had he known about it, was a way of drawing a connection between himself and Newton. We can see in this passage Rameau's desire to show that had Newton been aware of the principle, he would have applied it in his comparison of colour and music.

In *Nouvelles réflexions* Rameau returns to the geometric progression and attempts to clarify its relationship to the harmonic progression. Rameau argues that his expanded structure of closely related keys and the essential harmonies of a key unite the harmonic

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d'abord celles qui peuvent se comparer à des *Octaves*, à des *Quintes*: et après avoir reconnu la supériorité de ces *Quintes* dans l'Harmoniqe, et dans sa succession, sans doute qu'il se seroit conduit en conséquence." Rameau, *Nouvelles réflexions*, 63-64; Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 247-48.

[53] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 70.

and geometric progressions.[54] That is, Rameau expands the group of harmonies with relationships that are rooted in the geometric progression (F – C – G) to include the terms on either side of them – one term to the left of F and one term to the right of G. Rameau's ideal harmonic progression within a key would progress by fifth just as the progression did, and modulations to closely related keys would also include the harmonies in this progression. Thus, Rameau believed, the geometric progression could be seen as the principle underlying the harmonic progression and the two progressions were unified. For Rameau, this "reunification" symbolizes a connection he believed to be true of the whole of his music theory, namely that it brought together speculative musical thought and actual musical practice. The harmonic progressions of real music were thus connected to the geometric progression that exemplified rational musical principles.

Reviewers of *Démonstration* and *Nouvelles réflexions* easily picked up on Rameau's desire to use mathematics and science to further his reputation. Their negative comments conflicted with the reputation that Rameau had attempted to cultivate. One critical review of *Démonstration* said that Rameau should leave the theorizing to real scientists.[55] Briscoe writes that this was "contrary to all that our author believed about himself and especially was against his consuming desire for recognition as a scientist-philosopher himself."[56] The tension created by Rameau's different perspectives (as a musician and philosopher) is evident in his writing. Briscoe states:

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[54] Ibid., 62-63. Briscoe finds this "reunification" to be suspect.

[55] [Anonymous] "A Prospectus of a General Treatise on Music" (Soissons, 1752). The "Prospectus" is partially printed in Jacobi, *CTW*, V: xxiv-xxxi.

[56] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 73.

> This insistence that it takes a special combination of artist-musician and scientist-philosopher to discover the "principles of music" is a rather unscientific argument. But it allows Rameau to consider himself this unusual person who is somehow more than the sum of the individual parts and therefore above any criticism which might come from either side.[57]

Here I believe Briscoe makes a significant point. Rameau's concept of music and the tools needed for a true understanding of musical phenomena demanded a rare individual with a blend of particular talents and professional training. Using these criteria, Rameau himself would be the only person qualified to understand music. Here we can understand how he has positioned himself to be not just a *musician-savant*, but also the only true *musician-savant* of his time. In these terms it is easier to understand why he expected to become an Academy member. The persona he asserted for himself as an Enlightenment thinker and artist would certainly have been worthy of such recognition. However, as much as Rameau wanted this to be the case, the flaws in his science were clearly evident to the Academy members who read his works (and by modern Rameau scholars).

Castel is believed to have authored the review of *Nouvelles réflexions* published in the *Journal de Trévoux*.[58] In it he accused Rameau of having written his treatises after the *Traité* (including *Nouveau système*, *Génération harmonique*, *Démonstration*, and finally *Nouvelles réflexions*) in response to his original criticisms of the *Traité* two decades earlier. After summarizing Estève's criticisms, Castel claimed further that Rameau wrote *Nouvelles réflexions* in order to respond to Estève.[59] Somewhat

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[57] Ibid., 74.

[58] [Louis Bertrand Castel?] "[Review] *Nouvelles réflexions de Mr. Rameau sur sa démonstration du principe de l'harmonie, servant de base à tout l'art musical théorique et pratique*," *Journal de Trévoux* (August, 1752), 1856-1870; and (September, 1752) 1961-1973. Reprinted in Jacobi, *CTW* V, 151-62.

[59] Ibid., 1860-1862. See Estève, *Nouvelles découverte du principe de l'harmonie avec un examen de ce que M. Rameau a publié sous le titre de Démonstration*…(Paris: Huart et Moreau fils, Durand, 1751).

paradoxically, Castel notes that he himself had prompted Rameau to respond to Estève through another theoretical publication.[60] We can see Castel continuing to fan the flames of his contentious relationship with Rameau. In their mutual unwillingness to stand down from an argument, he and Rameau were more similar than they may have known.

After *Démonstration* and *Nouvelles réflexions*, Rameau published two more treatises: *Observations sur notre instinct pour la musique, et sur son principe* (1754) and *Nouvelles réflexions sur le corps sonore II* (1758-59). Rameau scholars have focused less attention on these two works because they cover the same basic material as his earlier writings. In each text, Rameau attempted to answer criticisms of his earlier theoretical work. According to Christensen, *Observations* was originally written as a response to Rousseau's public letter on French music from 1753,[61] while *Nouvelles réflexions II* dealt specifically with the *corps sonore*. As he had done with his other treatises, Rameau requested approval of *Nouvelles réflexions II* from a prominent intellectual, in this case Padre Martini. However, Martini did not give his approval of this work.[62]

Rameau also wrote to other prominent thinkers outside of France, requesting their approval of his work. These included men such as Bernoulli, Gabriel Cramer in Geneva, and Euler in Berlin. In writing to each of them, Rameau made a polite request for the recipient to send approval of his *Démonstration* and *Nouvelles réflexions*. In each letter,

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[60] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles réflexions*," 78. See Briscoe's discussion for more on Castel's review.

[61] Christensen, *Rameau and Musical Thought in the Enlightenment*, 248-49. For more on Rameau's *Observations*, Christensen directs the reader to Cynthia Verba, "The Development of Rameau's Thoughts on Modulation and Chromaticism," *Journal of the American Musicological Society* vol. 26, no. 1 (1973): 69-97.

[62] Christensen, *Rameau and Musical Thought in the Enlightenment*, 292-94. See also, Jacobi, *CTW* VI, 387-407.

Rameau makes several comments about his desire to be seen as both a musician and a mathematician, as well as his belief in music as a way of understanding nature through geometry. On February 18, 1750 he wrote to Bernoulli that "Acquaintance with this geometry has come to us, if I am not mistaken, by the aid of an infinity of operations which cause us to regard music as the mirror of nature in [music's] scientific aspect."[63] In other words, music reflects nature and this reflection thus makes it scientific.

Rameau wrote to Cramer on the same day, saying that his *Démonstration* had aroused interest among several philosophers. He argued that the philosophers needed his work because they would benefit from understanding music geometrically.

> They will see indeed that nature is itself geometry, and that it would have spared them much trouble and watchfulness if they had been able to discover what they sought in music. That is why, presently, the fruit of my labours is reduced if I might only procure for my art more accurate and more certain paths than those which we owe only to experience.[64]

Rameau sent letters to Bernoulli and Euler again in 1752 asking a second time for their approval of *Démonstration*, which they already had received, and of *Nouvelles réflexions*.[65]

Euler's reply on September 13, 1752 must have disappointed Rameau. He stated clearly that he could not give his approval for these works. Among other issues, Euler did

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[63] "[Une] géométrie naturelle, dont la connoissance ne nous est parvenue, si je ne me trompe, qu'à l'aide d'une infinité d'Opérations, ce qui peut faire regarder la Musique comme le Miroir de la Nature dans la partie sçientifique." Translated by and printed in Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 304; reprinted in Jacobi, *CTW* VI, lxxx-lxxxi.

[64] "[Ils] y verront bien que la Nature est elle même géomètre, et que cequ'ils cherchoient dans la musique leur auroit épargnè bien des peines et des veilles, s'ils eussent pû l'y découvrir; c'est à quoi se réduit aprésent le fruit des miennes, si ce n'est que je procure à mon Art des voyes plus seures et plus certaines que celles qu'on ne devoit encore qu'à la seule expérience." Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 306; *CTW* VI, lxxx.

[65] Rameau's letters to Bernoulli are reprinted in *CTW* V, 145 and *CTW* VI, 195-96; Rameau's correspondence with Euler is found in *CTW* V, 146-8

not agree with Rameau's concept of octave equivalence, but he was extremely polite throughout his letter. As Christensen says, Euler clearly made an effort to emphasize the points on which they agreed.[66] Rameau replied to Euler's letter, this time publically, and Euler did not respond.[67] From their correspondence we can see yet another example of Rameau seeking the support of an elite intellectual and trying to engage him publically, only to end the relationship by alienating him.

In addition to his engagement with Euler, Rameau's writing after 1752 involved intense arguments with Rousseau, d'Alembert, and Diderot, the three men most directly responsible for the publication of the *Encyclopédie*. His criticisms of both d'Alembert's *Élémens de Musique* and the *Encyclopédie* eventually ended their relationship.[68] In 1755, Rameau published a short essay called "Erreurs sur la musique dans l'Encyclopédie," focusing on the music articles that had been printed to that point, including those on accompaniment, *accord*, cadence, *choeur*, chromaticism, and dissonance.[69] Rameau's tone suggests that he considered the *Encyclopédie* articles to be a critique of his theories, rather than a straightforward exposition of his ideas.[70] It was well known that Rameau and Rousseau, who wrote many of the articles on music, already had a contentious

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[66] Christensen, *Rameau and Musical Thought in the Enlightenment*, 155 and also 245-47.

[67] Rameau's letter to Euler was published in *Mercure* in December, 1752, and in the spring of 1753 as a pamphlet entitled, *Extrait d'une réponse de M. Rameau à M. Euler sur l'identité des octaves* (Paris: Durand, 1753). See Christensen, *Rameau and Musical Thought in the Enlightenment*, 245.

[68] See Christensen, *Rameau and Musical Thought in the Enlightenment*, 259-60 for more on Rameau's relationship with d'Alembert and their falling out.

[69] The *Encyclopédie* was printed serially rather than as a whole. For more on the publication of the *Encyclopédie*, see Shank, *The Newton Wars*, 495ff., and Robert Darnton, *The Business of Enlightenment: a Publishing History of the Encyclopédie, 1775-1800* (Cambridge, MA: Belknap Press of Harvard University Press, 1979).

[70] *CTW* V, 198ff.

relationship.[71] Perhaps because of their prior disagreements, Rameau took Rousseau's articles on his musical concepts to be personal attacks. In rebuttal, Rameau referred to his writings on music theory and musical examples from his own works. Throughout this text, Rameau refers to the *corps sonore* as the principle that should guide musicians. One of his biggest complaints about the articles on "accompagnement," "accord," "cadence," "chiffrer," "choeur," "chromatique," and "dissonance,"[72] was that the *corps sonore* did not feature prominently enough in Rousseau's explanations.[73] Further, judging from the articles printed to that point (and their alphabetical order from A to D), he may have been offended that the *corps sonore* had not received its own entry in the *Encyclopédie*.

Rousseau published a response to Rameau's *Erreurs* in the same year. Among Rameau's various criticisms, Rousseau addressed his treatment of the *corps sonore*. He explains the concept of the *corps sonore* and then adds that every vibrating fundamental produces more than just the three pitches in the *corps sonore*, including some pitches that are not, in fact, consonant with the fundamental. Rousseau suggests that Rameau assigns particular significance to the three pitches of the *corps sonore* that constitute the major triad but that these pitches do not prove the natural basis of his harmonic system, as Rameau suggests.[74] From Rousseau's writing it is clear that he did not want to respond to

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[71] For more on Rameau's disagreements with Rousseau, see Christensen, *Rameau and Musical Thought in the Enlightenment*, Chapter 8: "Rameau and the Philosophes,"209-51. I have also addressed the musical articles in the *Encyclopédie* in Chapter 2.

[72] Jean-Philippe Rameau, *Erreurs sur la musique dans l'Encyclopédie* (Paris: Sebastien Jorry, 1755); reprinted in Jacobi, *CTW* V, 198-261.

[73] See for example Rameau's discussion of the significance of the *corps sonore* in the article on "dissonance." Ibid., 110; *CTW* V, 254.

[74] Jean-Jacques Rousseau, "Examen de deux principes avancés par M. Rameau, dans sa Brochure intitulée: 'Erreurs sur la musique dans l'Encyclopédie,'" (c. 1755): 340-342; reprinted in Jacobi, *CTW* V, 269-270.

Rameau's criticisms. However, the initial publication of the *Encyclopédie* articles had already withstood controversy and a governmental ban. [75] Given these circumstances, Christensen suggests that Rousseau and d'Alembert both may have felt that they had to respond.[76] Rousseau closes by saying that if Rameau wanted to attack him personally, then he has nothing more to say.[77] Rameau continued to publically criticize the Encyclopaedists in print for the rest of the decade. He replied to Rousseau's response in 1757 and published a public letter to d'Alembert about his comments on Rameau's music in 1760.[78] Rameau's attacks on Rousseau and the *Encyclopédie*, and his later public attacks on d'Alembert, effectively ruined his relationships with the authors who had attempted to promote his theory.

Shank believes it can be said that the *Encyclopédie* "triggered" the French Enlightenment by crystallizing knowledge in its publication.[79] Its publication had the effect of creating "a new program of Enlightenment in France, one that was about collectively serving the public through philosophical inquiry and the wide dissemination

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[75] Shank, *The Newton Wars*, 497.

[76] Rousseau, "Examen de deux principes avancés par M. Rameau," 334-373; reprinted in Jacobi, *CTW* V, 266-285. Christensen makes a similar point about d'Alembert and Diderot's individual responses to Rameau, *Rameau and Musical Thought in the Enlightenment*, 268.

[77] Rousseau adds that he sees Rameau only as a musician (i.e., not as a scientist or philosopher):"If this man appears soon and personally attacks me, I have nothing more to say to him and only see him as a musician." ["Si-tôt que l'homme se montre et m'attaque personnellement, je n'ai plus rien à lui dire; et ne vois en lui que le Musicien."] Ibid., 373; *CTW* V, 285. My translation.

[78] This letter was published with *Code de musique pratique ou méthodes pour apprendre la musique…avec de nouvelles réflexions sur le principe sonore* (Paris: Imprimerie royale, 1760). The same material is reprinted in Jacobi, *CTW* IV, 267-80.

[79] Shank, *The Newton Wars*, 499.

of useful knowledge."[80] The *Encyclopédie* reflected the relatively new consensus among the scientific community toward Newtonian physics. Shank sees a connection between the acceptance of Newton and the project of Enlightenment as realized through the *Encyclopédie*.[81] Additionally, controversy contributed to the popularity of both Newton's works (especially as Voltaire wrote about them) and the *Encyclopédie*. After the first articles were printed, the government banned further publications, though the articles in circulation increased in popularity. Diderot continued the project in spite of the ban.[82]

In light of the publication circumstances of the *Encyclopédie*, and its overall cultural significance to the French Enlightenment, Rameau's negative reaction to it is significant. He publically criticized and actively sought to distance himself from the document that is generally believed to be at the heart of the French Enlightenment. His rejection of this most iconic Enlightenment monument is most ironic, given Rameau's historical image as the music theorist whose work most clearly embodies Enlightenment thought.

Rameau's *Code du musique pratique, ou Méthodes pour apprendre la musique* (1760) was his last writing dealing with practical matters concerning music. His writings after the *Code* until his death in 1764 are generally regarded as eccentric as they address the metaphysical aspects of the *corps sonore* and other speculative issues. His *Origines des sciences, suivie d'un controverse sur le même suject* from 1762 was part of an ongoing debate with d'Alembert and is considered his most absurd discussion of the

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[80] Ibid., 497.

[81] Ibid.

[82] Ibid., 499.

corps sonore. Here he sought even more fervently to prove that the principle of the *corps sonore* underlay all the sciences.[83] He also believed that he had evidence that the *corps sonore* played a role in the history of other cultures, including the ancient Egyptians and Chinese.[84] In fairness to Rameau, Christensen notes that other philosophes employed the same sort of quasi-ethnographic theory and that it was part of the practice of the day.[85] Rameau's final theoretical statements are marked by his devotion to the *corps sonore* and his deep conviction that it lay at the heart of all knowledge. In the final years of his life, his quest for Academy membership ended.

Legacy

D'Alembert and Friedrich Wilhelm Marpurg are regarded as largely responsible for disseminating Rameau's theories within France and in German speaking parts of Europe. Christensen credits Marpurg with promoting Rameau's theories after his death through his translation of d'Alembert and with contributing to his legacy as a music theorist.[86] It is important to note that d'Alembert and Marpurg altered Rameau's original theories in ways that made them more accessible and more easily distributed. Both authors stripped Rameau's theory of its scientific content and attempted to boil it down to a pure music theory (focusing solely on musical issues).

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[83] Christensen, *Rameau and Musical Thought in the Enlightenment*, 294-95.

[84] Jean-Philippe Rameau, *Origine des sciences suivie d'une controverse sur le même sujet*, 2; reprinted in Jacobi, *CTW* IV, 288.

[85] Christensen, *Rameau and Musical Thought in the Enlightenment*, 296.

[86] Ibid., 253.

Through his *Élémens de musique théorique et pratique suivant les principes de M. Rameau* (1752), d'Alembert played a major role in popularizing Rameau's theories. He points out in his introduction that the *Élémens* does not contain the calculations that Rameau used in his original books because he believes we can understand the text without them:[87]

> We have likewise banished from this edition, as from the former, every consideration of geometrical, arithmetical, and harmonical proportions and progressions, which authors have endeavoured to find in the mixture and protraction of tones produced by a sonorous body; persuaded as we are, that M. Rameau was under no necessity of paying the least regard to these proportions, we believe to be not only useless, but even, if we may venture to say so, fallacious when applied to the theory of music.[88]

From his comments we can see that d'Alembert did not share Rameau's enthusiasm for elevating music theory to the status of a science. Indeed, he wrote in 1757 that he believed music theory could never be regarded as scientific: "Whence it follows that his music theory ranks only in the class of probability."[89] It follows, then, that d'Alembert did not include in his *Élémens* any of the scientific references, experiments, or other material connecting Rameau to contemporary science, which Rameau tried so hard to include in his own work.

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[87] Jean le Rond d'Alembert, *Élémens de Musique, théorique et pratique, suivant les principes de M. Rameau* (Paris: Charles-Antoine Jombert, Imprmeur-Libraries, rue Dauphine, 1759), iiij-vii-j. D'Alembert does include the mathematical content in the back of the book for those inclined to study it and he states that he finds Rameau's mathematical examples to be exceedingly simple.

[88] Jean le Rond d'Alembert, *Élémens de Musique*, in *Encyclopaedia Britannica*, 3rd ed. (1797). S. v. "Music" (An anonymous trans. of *Élémens de musique théorique et pratique, suivant les principes de M. Rameau*, rev. ed. preceded by a "Preliminary Discourse" [1762], by Jean le Rond d'Alembert), 12: 502. As quoted in Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 86.

[89] "D'où il s'ensuit, qu'il ne range sa théorie musicale que dans la class des probabilities." *Encyclopédie*, s. v. *Gamme*, vol. 7 (1757); trans. by Briscoe from James Doolittle, "A Would-Be Philosophe: Jean-Philippe Rameau," *Publication of the Modern Language Association* 74/3 (June 1959): 245. As quoted in Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 87.

D'Alembert did not use the concepts of "mutual lending" or "reciprocal power" to describe the *double emploi* or the subdominant as Rameau had in the 1730s. His text is, however, a very clear explanation of Rameau's theories, focusing especially on the material from the treatises of the 1750s. D'Alembert's interpretation also paints Rameau's theories in a favourable light and the initial short review of *Élémens* in *Mercure* was largely positive.[90] Rameau responded publically to the reviews, saying that he had been rewarded for progressing the art of music by receiving praise and esteem from intellectuals such as d'Alembert and from multiple academies. [91] In short, Rameau saw d'Alembert's *Élémens* as a positive addition to his own work that brought him more acclaim in the intellectual community.

The dissolution of Rameau's relationship with d'Alembert was perhaps the most significant of all his failed professional relationships. This rupture resulted from Rameau's reaction to the *Encyclopédie*, and from Rameau's attacks on Rousseau. Christensen gives an account of how d'Alembert defended both the *Encyclopédie* and Rousseau from Rameau's comments. This dispute prompted a longer, heated correspondence between Rameau and d'Alembert that ended their relationship permanently.[92] In this exchange, Rameau focused his criticisms on d'Alembert's choice to remove the scientific and especially mathematical content of Rameau's work from *Élémens*.

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[90] "[Review of] *Élémens de musique*," *Mercure* (March, 1752), 136-37; *CTW* VI, 236.

[91] "Lettre de M. Rameau à l'Auteur du Mercure," *Mercure* (May, 1752), 75-77; *CTW* VI, 238.

[92] See Christensen, *Rameau and Musical Thought in the Enlightenment*, 259-64.

In the period after Rameau's death, Marpurg began writing about music theory that was mainly based on Rameau's work. He first published a German translation of d'Alembert's *Élémens* in 1757.[93] In the preface to *Handbuch bey dem Generalbasse und der Composition* (1757) Marpurg writes that he took only the useful material from d'Alembert's work and left the rest.[94] Also like d'Alembert, Marpurg did not incorporate the Newtonian terminology that Rameau had used for dissonance and the subdominant. Nor did he rely on analogies from mechanics to describe these theoretical concepts as Rameau had.

In many ways, Marpurg's *Handbuch* is a faithful presentation of Rameau's work. For example, Marpurg explains the 7th as the source of all dissonance, as Rameau had from the beginning.[95] Significantly, however, Marpurg does not use the term "subdominant," one of the most Newtonian concepts in *Génération harmonique*; instead he calls this chord the "triad on the fourth degree."[96] In his translation, David A. Sheldon notes that in Marpurg's later text, *Versuch über die musikalische temperature* (1776), he does discuss the dominant as being generated above the tonic and the subdominant below the tonic.[97] However, Marpurg clearly does not wish to emphasize this aspect of Rameau's theory and the subdominant does not figure significantly in his writings. It may also be true that Marpurg did not understand the fundamental bass in both the vertical and

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[93] Briscoe, "Rameau's *Démonstration du Principe de l'harmonie* and *Nouvelles Réflexions*," 56.

[94] David A. Sheldon, *Marpurg's Thoroughbass and Composition Handbook, a Narrative Translation and Critical Study* (Stuyvesant, NY: Pendragon Press, 1989), x.

[95] Ibid., 61.

[96] Ibid., 52, see footnote 3.

[97] Ibid., xiv, see footnote 17.

horizontal dimensions in which Rameau had theorized it. As his theory is ultimately a thoroughbass method, Marpurg's discussion of the fundamental bass generally focuses more on chord roots and the verticality of chord structure in a progression than on horizontal movement.

Conclusions and Thoughts for Further Research

In this dissertation I have demonstrated that Rameau wanted to claim the prestige of contemporary science for himself for numerous reasons. Such prestige would have brought him social stability, along with potentially greater financial rewards. We have seen that in certain ways he was able to achieve this status. In other ways, his contemporaries criticized his use of science along with his ability to employ methodologies from scientific disciplines. Other readers reacted to his theory as a great achievement and believed that he had found a scientific basis for music. Ultimately, however, his disseminators in the eighteenth century removed this content from his work, viewing the scientific aspects as unnecessary for understanding musical phenomena.

By this point I hope to have situated Rameau's participation in French Newtonianism as a larger cultural movement. I hope also to have demonstrated that Rameau became entangled in the debates surrounding French Newtonianism in ways that he likely did not anticipate. My purpose for studying Rameau in this light has been to show that Rameau's theory, especially as articulated in *Génération harmonique*, was not inevitable, but arose in response to specific historical events and trends. By the time of his death, as his theories were disseminated across Europe, certain effects of those historical events were already naturalized in his theory, while others were removed from

it altogether. In other words, the trace of these trends and their historical context had already been erased long before twentieth-century scholars rekindled their interest in Rameau. Though Rameau did not consistently apply his scientific knowledge accurately or even usefully, studying these aspects of his theories shows how dominant discourses such as Newtonianism can set the terms for intellectual discovery, even in minor and apparently remote fields like music theory. With this knowledge in mind, we can speculate as to the reasons for his use of this scientific material, and show how science effected the development of music theory. Further, we can see *Génération harmonique* as a barometer for Newtonianism and its extension to cultural products that were not inherently scientific.

Having applied this method of inquiry to Rameau and his cultural and historical context, we can see the applicability of this methodology for other music theorists, both historical and modern. The same approach used to study Rameau could easily apply to other figures discussed here. Studying d'Alembert's writing on music through the lens of Enlightenment trends such as "Newtonianism" would be revealing. Such a study could also focus on the subsequent translations of d'Alembert's work and could continue the account provided here past the point of Rameau's death. The artistic products of Voltaire's and Rameau's collaborations would also benefit from such a reading. Though some information exists on *Samson*, much less scholarship exists on their other collaborations and the details of their relationship. Rameau's music did not figure in this project but it would be useful to study his compositions and their reception in more detail

with this historical context in mind (Charles Dill and Geoffrey Burgess[98] have already created some readings of Rameau's operas in this way but their work is not exhaustive). The implication of Rameau's revised concept of tonal space, as he theorized it in *Démonstration* and *Nouvelles réflexions*, and its connection to social and scientific trends, also merits further study.

More broadly, it would be interesting to study the relationship between amateur science and amateur music making in eighteenth-century France, especially the role of women in these activities. Scholars such as Elisabeth Le Guin[99] have studied embodiment and historical women musicians, and Sarah Hutton[100] has studied women's participation in Newtonianism. Further study is needed on the possible relationship between these two types of learned activities for wealthy, educated women, as well as their connections to eighteenth-century salon society.

Rameau and his circumstances still have much to tell us. The problems he encountered as an eighteenth-century theorist are still with us. From this study we can see that it is necessary to be aware that all music theories are situated and that no theory arises in a vacuum. As historical actors, our explanations for musical concepts are beholden to the conceptual language that we have at our disposal. An awareness of the

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[98] Charles Dill, *Monstrous Opera: Rameau and the Tragic Tradition*. Princeton: Princeton University Press, 1998; Geoffrey Burgess, "Enlightening Harmonies: Rameau's *corps sonore* and the Representation of the Divine in the *tragédie en musique*." *Journal of the American Musicological Society*, vol. 65, no. 2 (Summer, 2012), 383-462.

[99] Elisabeth Le Guin, *Boccherini's Body: An Essay in Carnal Musicology* (Berkeley: University of California Press, 2005).

[100] Sarah Hutton, "Women, Science, and Newtonianism: Emilie du Châtelet versus Francesco Algarotti." In *Newton and Newtonianism: New Studies*. Edited by James E. Force and Sarah Hutton, 183-203 (New York: Kluwer Academic Publishers, 2004).

situatedness of Rameau's theory may prompt us to become more aware of how we ourselves are tethered to history.

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