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RESEARCH ARTICLE

Making and taking theriac: an experimental and sensory approach to the history of medicine

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Abstract

This paper explores historically used medicaments by making them, or rather reworking them, in a modern laboratory and assessing them for taste, flavour and odour using sensory analysis and a trained panel of sensory assessors. Our test subject is the famous panacea theriac andromachalis, which is subjected to the methods of experimental history of science to create experimental data. We emphasize the importance of the sensory experience, in both the making and the taking of theriac. From antiquity and well into the nineteenth century, medical practitioners and patients held that the sensory qualities of medicaments were of significance. But sensory information is notoriously difficult to transmit textually, and today we know very little about the sensory characteristics of theriac, and other medicines of the past. This is a problematic lacuna in our knowledge of how actors perceived and used them. By choosing the reworking and sensory framework, we can approach early modern pharmacy both as a craft and as a creative process. Thus our study emphasizes the artisanal, or craft, aspect of medicine making. It indicates how the art of medicine making was integrated with and connected to a medical practice which relied heavily on direct sensory assessments of medicaments, disease and patients. Our purpose is, however, not to try to find out how historical medicine makers and patients 'really felt' when they experienced the act of smelling and tasting medicines. Our aim is rather to discuss what the sensory experience of making and tasting adds to the investigation of textual sources. Thus, by attempting to access information about the experience of medicine through experimental means, we aim to enrich and complement historical understanding of the medicines and medical theories of the past.

Theriac is probably the most famous of all compound medicines produced by ancient, medieval and early modern physicians and apothecaries. Theriac andromachalis, the classical version of theriac, was created by Andromachos the elder, a physician to the Roman emperor Nero. Its reputation as a panacea – a universal medicine – grew steadily already during Roman times. This was partly due to its exquisite pedigree, and it quickly became a fashionable drug among an elite Roman clientele. Galen himself administered it to Marcus Aurelius in his capacity as the emperor's personal physician.[1] Thus theriac, in its various subsequent incarnations, gained an enduring reputation as a powerful panacea.[2] Not only

1 Some key overviews are Robert Leigh, *On Theriac to Piso, Attributed to Galen*, Leiden: Brill, 2016; Laurence M.V. Totelin, 'Mithradates' antidote – a pharmacological ghost', *Early Science and Medicine* (2004) 9(1), pp. 1–19; Gilbert Watson, *Theriac and Mithridatium: A Study in Therapeutics*, London: Wellcome, 1966.

2 For an overview of discussions of poisons and antidotes in the classical Greek tradition see Frederick W. Gibbs, *Poison, Medicine, and Disease in Late Medieval and Early Modern Europe*, London: Routledge, 2020, pp. 1–38.

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was it an antidote to poison, but it also had the capacity to prevent the onset of disease if taken as a precaution, and to cure diseases that were already well advanced. Hence, it was 'the queen of all compound preparations', a potent symbol – and last resort – of the classical medical tradition as practised by both European and Arab physicians well into the eighteenth century and beyond.[3]

Today, theriac's reputation of old is mostly regarded as a curiosity. Along with the other compound preparations of classical, medieval and early modern European medicine, it has been consigned to the dustbin reserved for outdated medicines and medical practices. During the second half of the twentieth century, polypharmacy – the making of compound drugs with multiple ingredients – was, speaking very generally here, abandoned. The use of single active medical entities was now the golden route to treat disease.[4] Nevertheless, theriac has continued to raise interest as an object of historical study. We know a great deal about where and how it was manufactured, as well as about who used it, and for what purposes. As shown by several studies, theriac can be used as an inroad to learn more about the many connections between knowledge and knowledge production and trade and consumption. Hence its study is part of a bourgeoning field in contemporary history of science and medicine. There is a wealth of textual evidence available about theriac. Indeed, historian of science Barbara Di Gennaro Splendore notes, 'Early modern authors wrote about theriac more often and more regularly than about any other drug'.[5] Hence, one might ask, why would it be necessary to move beyond the study of textual documents, images and artefacts and reconstruct it?

The history of science and medicine has taken a material turn in the last decade or so, producing excellent studies of such diverse things as table salt and fireworks.[6] An important subfield in this 'turn' is the reconstruction, replicating, reworking and re-enacting of

For a valuable cultural-history approach to theriac and other panaceas in the Renaissance see Alisha Rankin, *Poison Trials: Wonder Drugs, Experiment, and the Battle for Authority in Renaissance Science*, Chicago: The University of Chicago Press, 2021; Rankin, 'Empirics, physicians, and wonder drugs in early modern Germany: the case of the Panacea Amwaldina', *Early Science and Medicine* (2009) 14(6), pp. 680–710. On the history of published texts on theriac and mithridate see Barbara Di Gennaro Splendore, 'The triumph of theriac: print, apothecary publications, and the commodification of ancient antidotes (1497–1800)', *Nuncius* (2021) 36, pp. 431–70. Among other more recent studies which discuss theriac are J. Griffin, 'Venetian treacle and the foundation of medicines regulation', *British Journal of Clinical Pharmacology* (2004) 58(3), pp. 317–25; Valentina Pugliano, 'Pharmacy, testing, and the language of truth in renaissance Italy', *Bulletin of the History of Medicine* (2017) 91(2), pp. 233–73; Carla Nappi, 'Bolatu's pharmacy: theriac in early modern China', *Early Science and Medicine* (2009) 14(6), pp. 737–64.

3 Christiane Nockels Fabbri, 'Treating medieval plague: the wonderful virtues of theriac', *Early Science and Medicine* (2007) 12(3), pp. 252–58. Quotation on 'the queen' from Paul Freedman, *Out of the East: Spices and the Medieval Imagination*, New Haven, CT: Yale University Press, 2008, p. 68.

4 Taking a *longue durée* perspective, late twentieth-century views of medicinals were shaped through a process which had begun already in the late Middle Ages, and which found an early and influential expression in Paracelsian advocacy of simple remedies and criticism of the alleged over-complexity of Galenic medicaments. For a concise introduction see David Gentilcore, *Food and Health in Early Modern Europe: Diet, Medicine and Society, 1450–1800*, London: Bloomsbury, 2016 pp. 27–48. For in-depth analysis see Allen G. Debus, *The Chemical Philosophy: Paracelsian Science and Medicine in the Sixteenth and Seventeenth Centuries*, New York: Science History Publications, 1977, vols. 1–2; Klaus Bosch, *Zur Vorgeschichte chemiatrischer Pharmakopöepräparate im 16./17. Jahrhundert*, Braunschweig: Technischen Hochschule Braunschweig 1980. For an important reinterpretation of the influence of Galenism see Michael Stolberg, *Experiencing Illness and the Sick Body in Early Modern Europe*, Basingstoke: Palgrave Macmillan, 2011.

5 Di Gennaro Splendore, op. cit. (2), p. 433.

6 Jakob Vogel, *Ein schillerndes Kristall: Eine Wissensgeschichte des Salzes zwischen Früher Neuzeit und Moderne*, Cologne: Böhlau, 2008; Simon Werrett, *Fireworks: Pyrotechnic Arts and Sciences in European History*, Chicago: The University of Chicago Press, 2010. These are just two examples; history of science works on objects are of course bountiful; see, for example, Lorraine Daston, *Things That Talk: Object Lessons from Art and Science*, New York: Zone Books, 2004; Sven Dupré and Christoph Lüthy (eds.), *Silent Messengers: The Circulation of Material Objects of Knowledge in the Early Modern Low Countries*, Berlin: LIT Verlag, 2011; Paula Findlen (ed.), *Early Modern Things: Objects and Their*

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historical objects and processes.[7] Several recent research projects also discuss the sensory experience of reworked historical objects, although many of them are still in their initial phases.[8] One other group, led by Sarah Craske and Martin Kluge, working from the Pharmaziemuseum der Universität Basel, Switzerland, has reproduced a complete theriac andromachalis. Like us, Craske and Kluge conceive their product as a pharmaceutical work of art to be experienced with the senses. However, Craske and Kluge's approach and aims are different from ours in several respects. They make works of art/replicated historical objects, intended to be experienced as works of art and/or as part of exhibitions. We use a process-oriented experimental history-of-science approach. In this we rely on work by, and help provided by, H. Otto Sibum and Lawrence M. Principe.[9] Both scholars contend that reworking experiments can contribute to the understanding of historical experimental and craft practices and that it allows researchers to connect with those levels of practice that are not accessible through literature. This includes the gestural knowledge of apothecaries, but also the sensory experience of taste, smell, texture and, to some extent, physiological effects. As Sibum puts it, reworking 'may help us to reconstitute tacit dimensions of past practices that were either taken for granted, kept secret and therefore not written down, or became victims of substitution by formal or mechanical representation'. We agree with Sibum's emphasis on reworking and rely on his term 'gestural knowledge'. Just as was the case of the Manchester brewing culture studied by Sibum, early modern apothecaries may be regarded as a gestural collective or community of practice possessing relevant knowledges and techniques that change over time. This collective is only in part accessible through textual evidence.[10]

For reasons which will be explained below, the theriac we rework is not a classical or medieval version, but an early modern one. Like many other early modern objects, but perhaps more than most, compound medicaments such as theriac were a part of many interlaced local, European and global flows and relationships. During the period, theriac and its ingredients were associated with a great number of evocative places, such as Venice, the East Indies, the Holy Land and Rome during the reign of the emperors. It functioned, in a sense, as a door, inviting not only health into the body, but also the wider world of the historical, the exotic and the strange into highly local sites of production

Histories, 1500–1800, London: Routledge, 2013; Lissa L. Roberts and Simon Werret (eds.), *Compound Histories: Materials, Governance and Production, 1760–1840*, Leiden: Brill, 2018.

7 Two overviews of historiography and early work (with slightly different emphasis) are Hjalmar Fors, Lawrence M. Principe and H. Otto Sibum, 'From the library to the laboratory and back again: experiment as a tool for historians of science', *Ambix* (2016), pp. 1–13; Sven Dupré, Anna Harris, Julia Kursell, Patricia Lulof and Martjee Stols-Witlox, 'Introduction', in Dupré, Harris, Kursell, Lulof and Stols-Witlox, *Reconstruction, Replication and Re-enactment in the Humanities and Social Sciences* Amsterdam: Amsterdam University Press, 2020 pp. 9–32. Two representative anthologies are U. Klein and E.C. Spary (eds.), *Materials and Expertise in Early Modern Europe: Between Market and Laboratory*, Chicago: The University of Chicago Press, 2009; P.H. Smith, A.R.W. Meyers and H.J. Cook (eds.), *Ways of Making and Knowing: The Material Culture of Empirical Knowledge*, Ann Arbor: University of Michigan Press, 2014.

8 Most such projects focus on cooking and food culture, but some include history-of-science and/or history-of-medicine research questions, for example Odeuropa, at https://odeuropa.eu, PI Inger Leemans (Amsterdam), and Alchemies of Scent, at www.alchemiesofscent.org, PI Sean Coughlin (Prague), both accessed 28 January 2021.

9 See, for example, Lawrence M. Principe, *The Secrets of Alchemy*, Chicago: The University of Chicago Press, 2013, esp. ch. 6; Principe, 'Chymical exotica in the seventeenth century, or, how to make the Bologna stone', *Ambix* (2016) 63, pp. 118–44; Otto Sibum, 'Reworking the mechanical value of heat: instruments of precision and gestures of accuracy in early Victorian England', *Studies in History and Philosophy of Science* (1995) Part A 26(1), pp. 73–106. Sibum, 'Science and the knowing body: making sense of embodied knowledge in scientific experiment', in Dupré *et al.*, *Reconstruction*, op. cit. (7), pp. 275–93.

10 Sibum, 'Reworking', op. cit. (9), pp. 73–5, 83–5, quotation at 76.

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and consumption. Thus it brought the exotic and the global to local societies and was a part of a wider pattern of consumption of luxury goods which gave early modern Europeans a sense of connected urbanity. In this way, theriac also highlighted the apothecary shop, contributing to making it a node which negotiated the relationship between local consumers and global trade networks. The apothecary, when adding one ingredient after another to the compound, also added strand after strand of associations and connections. This process made theriac a product which signaled wealth, power and connectedness to the wider world.[11] It was also this process which gave theriac its healing properties. As historian of science Christelle Rabier succinctly puts it, 'No living or inanimate material or product is medical as such: today as in the past, things are endowed with curative properties only through complex chains of manipulation and interpretation.'[12]

It is useful to consider theriac in spatial terms, and as a space, rather than as an object. Arguably, with its imperial and royal connotations, its elaborate and ritualistic manufacturing process and its approximately seventy exotic and European ingredients, theriac andromachalis functioned as a space of accumulation, a dominant form of space, and a focus of wealth and power.[13] Discussing theriac as a space, and, in particular, as a social space, we agree with philosopher Henri Lefebvre, that words on paper only go so far: 'when codes worked up from literary texts are applied to spaces ... we remain, as may easily be shown, on the purely descriptive level'. Proceeding from Lefebvre, we argue that theriac cannot be *read and written* into existence, but must be *produced* and *experienced*. Theriac was a medicinal product, not a text, and hence belonged to what Lefebvre calls the 'practico-sensory realm of social space'. Thus when one seeks to gain a greater historical understanding of what it was, it makes a lot of sense to bring back theriac into the realm of physical experience. Reworking theriac, we seek to comprehend the relationships which it embodies as well as the spatial practices of its production, and the representational practices and symbolisms which belong to it. To rework and then to taste theriac is to reproduce (to the best of one's abilities) a social space both of production and of consumption, neither of which can be readily accessed through the reading and analysis of written sources. Approaching theriac as a space, it is possible to situate it also as an early modern object, or thing, with properties and qualities.[14] And as our reworking will reveal, among the sensory properties of theriac, its taste and smell are the most important. This brings us to the relationship between space and objects, and the realm of sensory awareness and bodily experience.

By investigating the sensory properties of theriac, we chose not to produce theriac as a closed-off, insular object, a finished combination of other objects which constitute its ingredient parts. Instead, we examine the agency of theriac, i.e. a set of the actions that it produces, and which the body may be subjected to. This is in line with anthropologist Tim Ingold's assertion that objects are temporary 'entanglements' brought about

11 Hjalmar Fors, 'Medicine and the making of a city: spaces of pharmacy and scholarly medicine in seventeenth-century Stockholm', *Isis* (2016) 107(3), pp. 474–5, 493.

12 Christelle Rabier, 'Introduction: the crafting of medicine in the early industrial age', *Technology and Culture* (2013) 54(3), special issue, *Fitting for Health*, pp. 437–59, 439.

13 Henri Lefebvre, *The Production of Space*, Oxford: Blackwell, 1991 (first published 1974), 49, 275–9. See also Rankin, *Poison Trials*, op. cit. (2), pp. 23–46. Theriac, however, was primarily an object of consumption, not an object to be kept or treasured. Compare Renata Ago, *Gusto for Things: A History of Objects in Seventeenth-Century Rome*, trans. from Italian by Bradford Bouely and Corey Tazzara, Chicago: The University of Chicago Press, 2013 (first published 2006), p. 5.

14 These social spaces of production and consumption are both mental spaces/representations and physical spaces 'defined by practico-sensory activity'. Lefebvre, op. cit. (13), pp. 15, 27, 31, 33, 210–11, 224–6, quotations at 7, 15. It should be noted that Lefebvre does not consider space a thing, but a 'set of relations between things (objects and products)' and as 'a set of relations and forms'. Ibid., pp. 83, 116.

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through practical skilful working with 'materials, bodily gestures and the flows of sensory experience'. Scholarly studies of things, Ingold argues, need to shift perspective from objects and images to longitudinal trajectories of material flows and sensory awareness.[15] We contend that, without making and trying out theriac, we can only entertain vague notions about how theriac acted (back) on early modern bodies. We would have little idea about what bodily gestures, or gestural knowledge, goes into its making and what it tastes and smells like.[16] We would not know what its physiological effects are, and we could not guess at its potential or actual medicinal effects. It is by garnering knowledge from the 'practico-sensory realm' (Lefebvre) and paying due heed to longitudinal trajectories of material flows and sensory awareness (Ingold) that we make it possible to make claims about what functions theriac had in early modern societies. This also means that we can begin to approach head-on the big question: did theriac really work, or was it, and by extension other historical complex compound drugs, the rather medically useless oddity which it often has been portrayed as?

By refocusing from texts to experience, we seek to draw attention away from descriptions of theriac, and of the properties of its materials, and towards its qualities. This is in line with Galenic medical theory and practice.[17] We also highlight that the production of theriac was at its heart an artistic endeavour, conducted by professional craftspeople. We emphasize sensory experience, rather than physiological or medical effect, due to safety concerns. For this reason, we have produced our theriac under controlled laboratory conditions, and draw on contemporary pharmaceutical expertise. We have also taken several measures to make certain that our theriac would not produce physiological effects in those who have tested it. Hence we have excluded the most physiologically and medicinally active ingredients, such as opium, from our composition.

The first part of the paper consists of this brief overview of the history of theriac and of our theoretical considerations. The second part makes a brief review of the reworking experiments of two of the authors, Ahnfelt and Fors, during which they composed four different versions of theriac andromachalis in a modern laboratory setting between September 2015 and April 2018. In the third part of the paper, the product of their labours is submitted to sensory analysis under the aegis of food and meal scientist Wendin. The paper concludes with a discussion on what the reworking approach, and sensory analysis, can add to the investigation of textual sources.

Early moderns, of course, did not have access to contemporary methods and had a much more limited repertoire of laboratory tests at their disposal.[18] The history of pharmacy is a vast field, but, speaking very generally here, historical medicine makers relied predominantly on their own senses and bodily experience.[19] Taste, smell and visual

15 Tim Ingold, *Being Alive: Essays on Movement, Knowledge and Description*, London: Routledge, 2011, pp. 6, 10, 12, 16, 24. 'Materials' quotation at p. 16.

16 On the term 'gestural knowledge' see Sibum, 'Reworking', op. cit. (9), p. 76.

17 Michael McVaugh, '"Experience-based medicine" of the thirteenth century', *Early Science and Medicine* (2009) 14(1–3), pp. 105–30, 109–17, 127–9; Gentilcore, op. cit. (4), pp. 11–22. See also Manfred Ullman, *Islamic Medicine*, Edinburgh: Edinburgh University Press, 1978.

18 On early modern drug testing see the special issue of *Bulletin of the History of Medicine* (2017) 91(2), *Testing Drugs and Trying Cures*, ed. Elaine Leong and Alisha Rankin. See also Andreas-Holger Maehle, *Drugs on Trial: Experimental Pharmacology and Therapeutic Innovation in the Eighteenth Century*, Amsterdam: Rodopi, 1999; Rankin, *Poison Trials*, op. cit. (2).

19 For a comparably recent and major overview of the history of pharmacy see Rudolf Schmitz, *Geschichte der Pharmazie 1: Von den Anfängen bis zum Ausgang des Mittelalters*, unter Mitarbeit von Franz-Josef Kuhlen, Echborn: Govi-Verlag, 1998; Rudolf Schmitz, Christoph Friedrich and Wolf-Dieter Müller-Jahncke *Geschichte der Pharmazie 2: Von der Frühen Neuzeit bis zur Gegenwart*, Echborn: Govi-Verlag, 2005. An older, English-language overview is found in Edward Kremers and George Urdang, *Kremers and Urdang's History of Pharmacy*, 4th edn, Philadelphia: Lippincott, 1976. See also Stuart Anderson (ed.), *Making Medicines: A Brief History of Pharmacy and*

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inspection were important both in assessments of the pharmacological potential of ingredients and in evaluations of the medicinal effect of finished medicines. Customers and physicians too valued the sensory characteristics of medicines. For example, the pungent odour of asafetida, or the sharp bitter taste of gentian, were perceived as indicative of the medical efficacy of these substances.[20] Many of the substances that we consider mere household spices – such as pepper, cardamom and nutmeg – were considered powerful medicinals in their own right. They were also quite commonly used in medical compositions, masking bitterness and odours, and contributing their distinctive flavours and odours to mixtures, thus producing medicines that clearly must have been highly distinctive in taste, flavour and odour.[21] Consequently it is a viable theory that early moderns relied heavily on sensory characteristics to construe the identity and efficacy of theriac. Hence the aims of this paper. We want to learn more about what early moderns meant when they referred to theriac and produced judgements about its efficacy. To do this, we investigate its taste, flavour and odour. We want to demonstrate how reworking enriches and complements historical understanding of the medicines and medical theories of the past.[22] And finally, we want to investigate paths towards answering two big questions: *did theriac work, and if it did, how?* Some preliminary answers to these questions will be proposed in the concluding discussions.

This paper is concerned with the making of theriac, and the investigation of its sensory dimensions. It must, however, be emphasized what it does not do, or claim to do. Our purpose is neither to find out what early modern apothecaries 'really did', nor to try to find out how historical medicine makers and patients 'really felt' when they experienced the act of taking, smelling and tasting medicines.[23] Indeed, in a previous publication we used similar methods to show that sensory analysts, and by extension historical actors, must draw on their contemporary context and culture when describing the sensation of taste, flavour and odour of pharmaceutical simples.[24] We also do not seek to undermine traditional text-based historical scholarship. Instead, we show how the process of

Pharmaceuticals, London: Pharmaceutical Press, 2005. It should be noted that the latter is a history of English pharmacy, which was not representative of wider European developments. For this argument see Di Gennaro Splendore, op. cit. (2), p. 450.

20 Philip M. Teigen, 'Taste and quality in 15th- and 16th-century Galenic pharmacology', *Pharmacy in History* (1987) 29(2), pp. 60–8. R. Palmer, 'In bad odour: smell and its significance in medicine from the antiquity to the seventeenth century', in W.F. Bynum and R. Porter (eds.), *Medicine and the Five Senses*, Cambridge: Cambridge University Press, 1993, pp. 61–8; Stefan Halikowski Smith, 'The physician's hand: trends in the evolution of the apothecary and his art across Europe, 1500–1700', *Nuncius* (2009) 24(1), pp. 58–60. Steven Shapin, *Changing Tastes: How Foods Tasted in the Early Modern Period and How They Taste Now* (The Hans Rausing Lecture, 2011), Uppsala: Wikströms, 2011; India Mandelkern, 'Taste-based medicine', *Gastronomica: The Journal of Critical Food Studies* (2015) 15(3), pp. 8–21.

21 Nam Jong Kuk, 'Medieval European medicine and Asian spices', *Korean Journal of Medical History* (2014) 23, pp. 319–42. See also Benjamin L. Hart, 'The evolution of herbal medicine: behavioural perspectives', *Animal Behaviour* (2005) 70, pp. 975–89, 977, 980, 982–4.

22 'The fundamental aim of all experimental activity is to expand the boundaries of what the experimenter knows, and thus when the historian turns to experiment, his or her primary aim is to use experiments to obtain historical information that cannot be accessed by other means or from other sources. The "raw data" thus obtained consists of sensual experience derived from sight, smell, touch, sound and taste', Fors, Principe and Sibum, op. cit. (7), p. 12.

23 There is widespread agreement among researcher engaged in reconstruction, replication and re-enactment (RRR) that it is impossible to 'fully re-create the past' and that this should not be an aim of RRR studies. See Dupré *et al.*, 'Introduction', op. cit. (7), p. 22. On the experience of patients see Stolberg, op. cit. (4), pp. 8–9.

24 Nils-Otto Ahnfelt, Hjalmar Fors and Karin Wendin, 'Historical continuity or different sensory worlds? What we can learn about the sensory assessment of early modern pharmaceuticals by taking them to a trained sensory panel', *Berichte zur Wissenschaftsgeschichte*, special issue, *Rethinking Performative Methods in the History of Science*, Fall 2020 (ed. M.M.A. Hendriksen), pp. 412–29.

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reworking supplements traditional methods, and enables us to ask new questions, which would have been difficult to arrive at if we had limited ourselves merely to the study of historical texts and preserved artefacts.

Why an early modern, and not a classical, theriac?

The first question that confronts someone who wants to make theriac is which recipe to use. In medieval Europe the most celebrated theriac was manufactured in Montpellier, which also was the site of one of the most famous medical universities. The theriac of Montpellier contained eighty-three ingredients. Its manufacture was a serious business. The ingredients were laid out for inspection by the public, and after being found adequate, they were mixed in a public ceremony.[25] But there were other competitors for the title of producers of the best theriac in Europe. During the early modern period, the theriac of Venice rose to prominence, and became the benchmark against which other theriacs were measured. Due to their city's key role in the spice trade, the apothecaries of Venice had access to recently imported, high-quality pharmaceutical simples. In Venice, too, the manufacture of theriac was subject to ritual. There too, it was a public spectacle which involved the presence of an audience as well as physicians charged with inspecting the ingredients. These practices were set in place to protect against fraud, but were also highly effective devices to market and protect the brand name of the product. Montpellier and Venice theriac were exported far and wide. Nevertheless, these cities by no means held a monopoly. There were a great number of different theriacs available in the early modern medical market and many cities and towns made the manufacture of theriac a public spectacle. It was not uncommon that the successful production of theriac was followed by the publication of a pamphlet which documented the event and the procedure used. As observed by Pugliano, short essays on theriac and its ingredients were an important genre of publication among early modern Italian apothecaries, and signalled 'the culmination of the professionalization of the trade begun in the fifteenth century'.[26]

Early modern recipes for theriac were a classical inheritance, but also subject to scholarship and innovation. Di Gennaro Splendore, in an overview of early modern publications on theriac, identifies four phases in early modern understanding of theriac. The first phase, spanning 1497–1530, she characterizes as mostly scholarly, and consisted of re-publication of classical and medieval sources. This phase resulted in an early consensus among scholars that the presently produced theriacs were not 'true' classical theriacs, but 'fake' products because of their use of incorrect ingredients. The second phase, 1530–70, saw an increase in publications. Focus was still mostly on the scholarly discussion of classical texts, but during this period a small group of elite apothecaries and physicians also began to experiment with reproducing the classical theriac, hoping that it might have been an effective remedy for plague. The third and longest phase, 1570–1710, Gennaro Splendore describes as 'the heyday of theriac', with hundreds of writers contributing to the literature. These texts often focused on production, presenting recipes, methods of making and an extensive discussion of each of the ingredients in the composition. Many of these texts were published in vernacular languages and reached wide audiences, consisting both of professionals and of members of the public. The fourth and final period, 1710–1800, saw a continuation of widespread production of theriac, but paired with a decline in the number of publications, and increased skepticism towards the drug. As Gennaro Splendore notes, theriac's strength lay in openness, not in secrecy. Recipes and

25 Freedman, op. cit. (3), p. 68.
26 Pugliano, op. cit. (2), p. 239; see also p. 266.

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procedures were public and subject to public scrutiny.[27] Theriac is indeed a very complex object. But it is nevertheless an excellent candidate for reproduction/reworking. It is unique among early modern medicaments, as there are an exceptionally large number of clear, concise instructions on how to make it, and on what ingredients to use in the composition.

The correct ascertainment of the ingredients of theriac was an important theme for early modern pharmacy, botany and philology. An important *topos* of this literature was that the classical ingredients of theriac were, or could be, unstable entities: prospective makers could not be sure which substances the classical descriptions signified, how they had been processed and how they should be prepared. This should not come as a surprise as theriac was indeed a reproduced medicament already during early modern times. To draw on just one example, there was an ongoing discussion on how to correctly identify the species of the balsam tree, as described in antique sources. Seventeenth- and eighteenth-century sources indicate that during that period balsam was almost impossible to obtain. Thus substitutes, such as balsam of Peru, had to be used.[28] Although a kind of agreement of what constituted a true theriac andromachalis began to emerge towards the end of the sixteenth century, local variations existed. What constituted a real theriac and who could make it were, at the bottom line, decided by local authorities and hence delineated in prescribed pharmacopoeias.[29] For the practically minded reworker, this means that it is not important which specific early modern recipe and manufacturing description one reproduces/reworks, if one only sticks to the chosen recipe.

The recipe and manufacturing description that we have used is from a rather unknown northern pharmacopoeia, the *Pharmacopeja Holmiensis* (1686).[30] The *Holmiensis* theriac is a typical example of a seventeenth-century theriac: it is based on a classical recipe as established through Renaissance and seventeenth-century scholarship. Like almost all early modern pharmacopoeias, the *Holmiensis* was mainly a compilation of earlier recipes, while also showing some signs of originality. It was written/compiled by a physician, Johan Martin Ziervogel, for the Swedish Collegium Medicum, and sourced a great number of its recipes, including, apparently, with minor variations, the one for theriac andromachalis, from the *Pharmacopeia Augustana*.[31] From 1564 and onwards throughout the early modern period, the Protestant city of Augsburg produced several editions of this famous pharmacopoeia. A product of late Renaissance sentiments and endeavours, it sought to re-create the knowledge of the ancients by returning to and re-examining the original sources and pruning away such errors as had accumulated during the intervening centuries. The *Augustana*'s editing team comprised physicians and apothecaries who were well versed in the humanist tradition, and who also took care to include knowledge garnered from the latest botanical works. Hence the *Augustana* – and the German pharmaceutical

27 Di Gennaro Splendore, op. cit. (2), pp. 442–9, 460. Theriac was, however, only dismissed by a single well-known author of the period. This author was William Heberden, in his 1754 publication *Antitheriaka* (ibid., p. 449). On theriac and plague see also Rankin, *Poison Trials*, op. cit. (2), pp. 43–6.

28 Marcus Milwright, 'The balsam of Matariyya: an exploration of a medieval panacea', *Bulletin of the School of Oriental and African Studies, University of London* (2003) 66(2), pp. 193–209, 196–8, 200–1 for the use of balsam in theriac. See also Pugliano, op. cit. (2), pp. 253, 267, 272; Elly R. Truitt, 'The virtues of balm in late medieval literature,' *Early Science and Medicine* (2009) 14(6), *Indigenous vs. Foreign: Early-Modern Materia Medica in Comparative Perspective*, pp. 711–36. This substitute substance is also what has gone into our composition, but as our seventeenth-century recipe for theriac states that it is the correct substance we do not count it as a substitution.

29 Di Gennaro Splendore, op. cit. (2), p. 460.

30 [Johan Martin Ziervogel] *Pharmacopoeja Holmiensis: Galeno-Chymica* (Stockholm, 1686). The ingredients for theriac on pp. 48–9.

31 Sten Lindroth. 'Förord', in [Ziervogel] *Pharmacopoeja Holmiensis*, op. cit. (30), pp. ii–iii. We assume that Ziervogel would have used a roughly contemporary edition such as *Pharmacopoeia Augustana* (Rotterdam, 1653), theriac recipe on pp. 400–2. It should be noted that there are also variations in the recipe between different editions of the *Augustana*. See *Pharmacopoeia seu medicamentarium pro Rep. Augustana* (Augsburg, 1573, 1597).

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scene more generally – firmly connected with the lively discourse on botany and pharmacy which had its center in Renaissance Italy.[32]

We have not chosen this recipe because it was an important recipe from the point of view of early modern Europeans. The reason we have chosen it is that the *Holmiensis* recipe is an excellent candidate for reproduction from the point of view of substance identification. The *Holmiensis* remained the official Swedish pharmacopoeia into the 1770s. Hence its botanical and zoological nomenclature was used by Carl Linnaeus and his immediate circle of associates among Swedish physicians and naturalists. Hence it is easy to establish the modern names for substances mentioned in the *Holmiensis*, as they can be cross-checked against Linnaeus's associate Peter Jonas Bergius's Linnaean *Materia medica* of 1778.[33] This means that the *Holmiensis* can be used as a relatively secure bridge between pre-Linnaean and post-Linnaean botanical and zoological description.

The theriac andromachalis of the *Pharmacopoeja Holmiensis* comprises sixty-four simple ingredient substances and two additional composite medicaments. These are agaricus trochiscatus and troches of hedychroi, which are prepared separately before they are mixed into the larger bowl containing the simple ingredients. The total number of ingredients is hence seventy-three. A list of the simple ingredients is given in Table 1 and lists of the ingredients of agaricus trochiscatus and troches of hedychroi are reproduced in Table 2.[34]

As is apparent, theriac andromachalis contains ingredients from plant, animal and mineral realms. Not to become overwhelmed, we have chosen not to investigate growth, harvesting and transport of substances, but begin our work at the apothecary's end of the manufacturing and sales network. This means that, just like early modern apothecaries, we have had to trust the integrity of our supply chains and have relied mostly on goods that have been purchased from regular food stores and specialist suppliers.[35]

Parsley seeds, cloves and (Spanish) honey were purchased at the ICA Maxi food store outside Uppsala, Sweden. Deep-frozen frog's legs (*Hoplobatrachus rugulosus*, substituting

32 Richard Palmer, 'Medical botany in northern Italy in the Renaissance', *Journal of the Royal Society of Medicine* (1985) 78, pp. 149–57; Pugliano, op. cit. (2), p. 233–73. See also Hanna Murphy, *A New Order of Medicine: The Rise of Physicians in Reformation Nuremberg*, Pittsburgh: University of Pittsburgh Press, 2019, pp. 21–43.

33 Peter Jonas Bergius, *Materia medica e regno vegetabili, sistens simplicia officinalia, pariter atque culinarian Secundum systema sexuale, ex autopsia & experientia. I-II*, Stockholm: Petri Hesselberg, 1778. An excellent overview of the substances and products of artisanal pharmacy is John Lindgren and Lauritz Gentz, *Läkemedelsnamn: ordförklaring och historik*, Lund, 1986 (first published 1918). We have also used earlier German overviews of objects from the three realms of nature, such as Johann Hübner, *Curieuses und Reales Natur- Kunst- Berg- Gewerck- und Handlungs-Lexicon ...*, Joh. Friedr. Gleditchens sel. Sohn, 1731; Michael Bernhard Valentini, *Museum museorum, oder vollständige Schau-Bühne ... aller Materialien und Specereyen. Zweyte Edition*, Frankfurt am Main: J.D. Zunner & Zunner's witwe, J.A. Jungen, 1714; as well as later books on how to assess pharmaceuticals, esp. Per Olof Almström, *Handelsvaru-kännedom eller underrättelse om de förnämsta handels-artiklars ursprung, produktionsställen och beståndsdelar ... förvaring och behandling*, Stockholm, 1845; Carl Edmund Lennmalm, *Handbok i handelsvarukännedom eller i kunskapen om de förnämsta handelsvarors ursprung, egenskaper, förfalskningar m.m.*, Stockholm: Zacharias Hæggström, 1868.

34 The number of entries in the two tables combined is larger. This is due to that troches of hedychroi contains several ingredients which also enter the composition as simple substances. Hence these ingredients are listed in both Table 1 and Table 2.

35 It should be noted that ethnobotany and historical bio-assaying have identified several problematizing factors when finding modern equivalents of medicinal plants described in historic descriptions. First, it is rather difficult to ascertain what species or subspecies of plant was used. Second, medicinal properties can vary depending on growing conditions such as soil, temperature and moisture. Important facts can also be omitted from the text, for example the season when the plant should be harvested and how it was dried and stored. Furthermore, exotic spices and medicines used in early modern European medicine come with a set of problems of their own, namely how the goods were affected by long-distance transport on camelback or in the holds of wooden ships.

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Table 1. Simple ingredients in theriac andromachalis according to the *Pharmacopoeja Holmiensis* ([Ziervogel] 1686), with modern names of substances given in Latin and English. Please note that several of the substances below were not present in the theriac given to the test panel.

Pharm. Holmiensis 1686	Latin plant name	English
Classis I		
Iris Illyric.	*Iris germanica*	Orris
Zedoaria loco Costus odoratus	*Curcuma zedoaria* (Christm.) Roscoe	Zedoary
Rad. Pentaphylli	*Potentilla reptans* L.	Cinquefoil
Aristolochia longa	*Aristolochia clematitis* L.	Birthwort
Phu Pontic ant Valerian. Nostr.	*Valeriana officinalis* L.	Valerian
Classis II		
Semen Dauci cretic.	*Athamanta cretensis*	Caraway seeds
Sem. Napi Gothlandic loco Buniadis	*Brassica napus*	Rapeseed
Anisum torrefact.	*Pimpinella anisum*	Anise
Seseleos fragilis Massiliens.	*Seseli tortuosum* L.	Hartwort
Sem. Foeniculi	*Foeniculum vulgare* L.	Fennel
Thlaspi	*Thlaspi arvense* L.	Pennycress
Ammeos	*Ammi visnagae* L.	Bishop's weed
Sem. Petroselini Maced.	*Athamanta macedonica* Spreng.	
Piper nigr.	*Piper nigrum* L.	Black pepper
Piper alb.	*Piper nigrum* L.	White pepper
Classis III		
Comae Marrubii	*Marrubium vulgare* L.	White horehound
Nepetha s. Calaminth. Mont. Odorat.	*Nepeta cataria* L.	Catnip
Radix Dictamni alb	*Dictamnus albus* L.	Dittany, burning bush
Polium creticum	*Teucrium creticum* L.	
Chamaedryos cretic. Comae	*Teucrium chamaedrys* L.	Wall germander
Chaemaepitys ramorum	*Teucrium chamaepityhys* L.	
Comae Scordii nostrat.	*Teucrium scordium* L.	Water germander
Agaricus Trochicat., cf. Table 2	*Lacrifomes officinalis*	Troches of agarikon
Classis IV		
Rhabarbarum	*Rheum palmatum* L.	Chinese rhubarb
Zingiber.	*Zingiber officinalis* Roscoe	Ginger
Stoechas arabic	*Lavandula angustifolia* Mill.	Lavender
Comae Hypericae	*Hypericum perforatum* L.	St Johns wort
Nardus Celticae	*Valeriana officinalis* L.	Valerian

(*Continued*)

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Table 1. (*Continued.*)

Pharm. Holmiensis 1686	Latin plant name	English
Carpobalsamum vel Cubebae	*Piper cubeba* L.	Cubeb
Terra Lemnia vera		Lemnian earth
Centaurii min. comae	*Centaurium erythraea* Rafn.	European centaury
Fol. Dictamni cret. el. Cariophyllorum	*Syzygium aromaticum* L.	Cloves
Fol. Malabathri vel ejus loco Macis et Caryophyllorum	*Myristica fragrans* Houtt.	Nutmeg (flower), mace
Rosae rubr. Exsicc.	*Rosa glauca*	Red-leaved rose
Classis V		
Rad. Gentianae	*Gentiana lutea* L.	gentian
Meum s. Angelica	*Athamantha Meum* L.	wild celery
Pulvis Viperanum italic	*Vipera berus* L.	Viper meat (toasted)
Troches of hedychroi, cf. Table 2		
Classis VI		
Acorus s. Calamus Aromat	*Acorus calamus* L.	Calamus
Cardamomum min.	*Elettaria cardamomum* (L.) Maton	Cardamom
Amomum racemosum	*Amomum sp.*	Black cardamom
Piper longum	*Piper longum* L.	Long pepper
Cassia lignea vera	*Cinnamomum aromaticum* Nees	(Chinese) cassia
Cinnamomum acut.	*Cinnamomum verum* J. Presl.	Cinnamon
Classis VII		
Nardus Indicae	*Nardostachys grandiflora* D.C.	Indian nard, jatamansi
Herba Schoenanthi sine Juncus odoratus		Palm rose/ginger grass
Crocus Austriacus	*Crocus sativus* L.	Saffron
Castoreum	*Castor fiber*	Castoreum
Terra Lemnia vera		Lemnian earth
Classis VIII		
Styrax calam. Rubr.	*Styrax officinalis* L.	Styrax
Thur. Mascul. Pellucid.	*Boswellia sacra* Flueck.	Frankincense, olibanum
Bitumin. Judaici s. Asphalt.		Asphalt from Judea
Terebinth. Venet.	*Pistacia terebinthus* L.	Turpentine
Myrrha electa	*Commiphora myrrha* (Nees) Engl.	Myrrh
Sagapenum	*Ferula asa foetida* L.	Devil's dung
Opoponax	*Commiphora kataf Engl.*	Opopanax, opobalsam

(*Continued*)

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Table 1. (*Continued.*)

Pharm. Holmiensis 1686	Latin plant name	English
Galbanum	*Ferula gummosa* Boiss.	Galbanum
Opium praeparat	*Papaver somniferum* L.	Opium
Gummi arab. splendid.	*Acacia senegal* (L.) Willd.	Gum arabic
Succus Acaciae	*Acacia arabica* (Lam.) Willd.	Acacia, babul
Succus Hypocistidis	*Cytinus hypocistis* L.	
Succus Glycyrrhizae	*Glycyrrhiza glabra* L.	Licorice
Vinum hispanic.	*Vitis vinifera* L.	Wine
Balsam. Peruvian loco opobalsam.	*Myroxylon balsamum* (L.) Harms	Balsam of Peru
Succus vel pulpa Scillae	*Drimia maritima* (L.) Stearn	Squill, sea onion
Chalcitis tost.		Red ochre
Mel	*Apis mellifera*	Honey

European viper) were purchased at an Asian food store in Stockholm, Sweden. Carrot seeds were purchased at the Plantagen gardening store, Uppsala, Sweden. Clay (substituting for terra lemnia) was obtained from the soil in Näs-Söderby outside Uppsala, Sweden. Castoreum (*Castor fiber*) in 40 per cent ethanol was a gift from John Andersson, Uppsala, Sweden. Turpentine (*Pistacia terebinthus* L.) and red ochre were obtained from Kulturhantverkarna AB, Stockholm, Sweden. The recipe states wine from Spain and we used a white wine (Falanghina del Sannio bought at Systembolaget, Sweden). A total of fifty-one substances were purchased from Galke GmbH, a supplier of plant materials to the Pharmacognosy Division at Uppsala University. This brings the number of ingredients in the theriac presented to sensory assayers to a total of sixty-one. The missing twelve substances were substituted by weight using other ingredients already present in the composition.

The issue of substitutions is important and needs to be commented on. Indeed, although we later composed theriacs containing more of the ingredients called for in our original recipe, the theriac that we submitted to taste, flavour and odour assessment contains a great number of substitutes. For example, it contains neither opium nor the meat of the European viper, both considered signature ingredients of theriac andromachalis.[36] Hence it would be possible to argue that we have not offered our sensory panel theriac andromachalis at all. However, substitution of the ingredients of theriac has always

36 Birthwort (*Aristolochia clematitis* L.), being nephrotoxic, was substituted with valerian; see John Scarborough and Andrea Fernandes, 'Ancient medicinal use of Aristolochia: Birthwort's tradition and toxicity', *Pharmacy in History* (2011) 53(1), pp. 3–21. Pennycress (*Thlaspi arvense* L.) was substituted with parsley seeds; *Teucrium creticum* L., *Teucrium chamaepityhys*, L. and water germander (*Teucrium scordium* L.) were all substituted with wall germander (*Teucrium chamaedrys* L.); nutmeg flower (*Myristica fragrans* Houtt.) with cloves; viper meat (*Vipera berus* L.) was substituted with frog's leg meat, which was first boiled and toasted in an oven at 100 °C for two hours and then ground into a powder using a stone mortar; Lemnian earth was substituted with clay from soil outside Uppsala, Sweden, that had been mixed with water and formed into a thin dough and dried in an oven at 100 °C for two hours; asphalt from Judea was substituted with styrax (*Styrax officinalis* L.); devil's dung (*Ferula asa foetida* L.) was substituted with cinnamon; opium was substituted with licorice; and finally *Cytinus hypocistis* L. was substituted with gum arabic. In the case of troches of hedychroi in Table 2, yellow sandalwood was substituted with styrax (*Styrax officinalis* L.) and African opoponax (Commiphora kataf. (Forssk.) Engl.) was substituted with opopanax (opobalsam).

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Table 2. Ingredients in agaricus trochiscatus and troches of hedychroi according to the *Pharmacopoeja Holmiensis* ([Ziervogel] 1686).

Pharm. Holmiensis 1686	Latin	English
Agaricus trochiscatus		
Agarici alb & levis 2 uns		
Agaricus albus	*Lacrifomes officinalis*	Agarikon
Vinum hispanic		
Troches of hedychroi		
Lign. Asphalti vel santali citrin	*Santalum album* L.	Yellow sandalwood
Fol. Majoranae	*Origanum vulgare*	Oregano
Radix Dictamni alb	*Dictamnus albus* L.	Dittany, burning bush
Radix asari	*Asarum europaeum* L.	European wild ginger,
		Hazelwort
Calami Rhiz	*Acorus calamus* L.	Sweet flag, calamus
Herba Schoenanthi sine Juncus odoratus	*Cymbopogon martinii*	Palm rose/ginger grass
Phu Pontic ant Valerian. Nostr.	*Valeriana officinalis* L.	Valerian
Xylobalsami s. lign Aloës.	*Commiphora kataf* (Forssk.) Engl.	African opoponax
Opobalsami s. ol. Nuc. Mosch. Expr.	*Commiphora roxburgi*	Bdellium, opobalsam
Cinnamomum acut.	*Cinnamomum verum* J. Presl.	Cinnamon
Myrrha electa	*Commiphora myrrha* (Nees) Engl.	Myrrh
Fol. Malabathri vel ejus	*Myristica fragrans* Houtt.	Nutmeg (flower)
loco Macis et Caryophyllorum		
Nardus Indicae	*Nardostachys grandiflora* DC.	Indian nard
Crocus Austriacus	*Crocus sativus* L.	Saffron
Cassia lignea vera	*Cinnamomum cassia* Blume	Chinese cinnamom
Cardamomum min.	*Elettaria cardamomum* L.	Cardamom
Mastichis	*Pistachia lentiscus* L.	Lentisk, mastic
Costi Arabici	*Saussurea costus* (Falc.) Lipsch	Costus, kuth

been a necessity and it can also be noted that precisely this type of criticism was levelled at the theriacs of the past.

Bartolomeo Maranta, author of possibly the most popular treatise on theriac of the sixteenth century, states that the physicians allowed the use of substitutions. Five or six are acceptable, but if fifteen or twenty of the ingredients are missing, then the product will no longer be theriac, but something else (*res alia*). When substituting, one should try to the best of one's ability to find correspondence in odour and taste and in occult and other qualities, or to use plants of similar type. Hence it is legitimate to substitute cassia with cinnamon, one root with another, and so on. One should also take into account whether they produce similar reactions when worked on in the laboratory, whether

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they have similar degrees of subtlety and penetration, and so on.[37] Indeed, as Pugliano observes about Italy, 'throughout the sixteenth century the race to create the perfect version of Andromachus and Galen was fought over the number of succedanea [substitutions] employed: from twenty to twelve to seven, until Calzolari allegedly triumphed by using only three.'[38]

What Pugliano's examples show is that the use of substitutes and the research and effort needed to make decisions about what can be substituted for other ingredients are important parts of the process of making a theriac. Indeed, each and every substance that we used would be questionable, if the idea were to produce a faithful copy of a postulated original. An example is chalcitidis. Mentioned by Hippocrates, this was an iron-based medicament somewhat strangely called 'copper-stone' (*khalkítitis*). It was sourced from the run-off water of mines and probably consisted of native, copper-bearing iron vitriol which was processed into a powder. There was a corresponding product sold at early modern pharmacies, vitriolum viride. We, however, used chemically pure iron vitriol artificially manufactured with acid, which in early modern parlance would have been another product: crocus martis.[39] One could argue that it would have been better to find the original product, or, failing that, to perform an analysis of water from an appropriate mine and then mix our iron vitriol with impurities. It is after all conceivable that even a small content of copper or other metallic substances in the theriac would lead to substantial differences in the final result in ways which we cannot conceive or comprehend. But remember that we are dealing with seventy-three different substances in this mixture: whatever we do, the end result will be an unknown entity, and definitely not a faithful copy of a sample produced by an early modern apothecary.[40]

Problems of this type are what led us to conclude that reworking, rather than reproducing, is a proper approach when doing practical work in historical pharmacy. There were also a couple of instances when we decided not to use the correct substance, although it was available to us. An example is our decision not to use viper (*Vipera berus*, the common European adder), although we received the offer to source vipers from a local Uppsala golf course, on which they were occasionally killed by lawnmowers.[41] But as the viper is a protected species according to the Berne convention, we chose to use this as a constraint on our work, as to not inspire others to use protected species for historical reproduction work. As most snakes and adders nowadays are rare, we do not wish to encourage their use for experimentation. Therefore we used frog's legs from an East Asian foodstore.[42] Such decisions were not consistent with the aim of reducing the number of substitutes as much as possible, but were consequences of our decision to focus on reworking, i.e. learning the process of making.

37 Bartolomeo Maranta, *Libri duo de theriaca et mithridatio* (trans. Joachim Camerarius), Frankfurt am Main: Engenolphi, 1576, pp. 28, 34.

38 Pugliano, op. cit. (2), p. 249.

39 Lindgren and Gentz, op. cit. (33), pp. 138–40.

40 Historical samples of theriac will not do, as the maturation process of theriac produces substantial changes as some compounds decompose and others are created.

41 The recipe in the *Holmiensis* calls for 'Pulvis Viperanum italic', 'Italian viper powder', by which was probably meant a trade product: pulverized trochisks (pills) made from Italian vipers collected in the Euganean hills during the month of April. See Christopher Meyer, *Theriacam Andromachi, a Christophoro Meyero, Pharmacopoeo, XX. Januar. M.DC.LIV. confectam*, Königsberg, 1654, p. 5. In comparison, Maranta gives a detailed procedure for preparing live adders into trochisks and cautions that it is absolutely necessary that the meat is completely pulverized and dried out, to preclude rotting of the substance. Maranta, op. cit. (37), pp. 40–1. It is for this reason that we roasted our substance at a low temperature.

42 An alternative would have been to substitute adder with plant matter; see Maranta, op. cit. (37), p. 37.

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The sensory experience of making theriac

The physical preparation of theriac is not all that complicated. Once the simple substances – predominantly various dried parts of plants – are laid out in order, it is mostly a matter of hard work. It consists of the weighing, grinding, sifting, dissolving and mixing of substances over a period of a few days.

To make theriac andromachalis according to the seventeenth-century recipe in the *Pharmacopoeja Holmiensis*, substances of classes I to VII were ground in a stone mortar. Class VIII compounds were divided into three subclasses which were brought into solution using either turpentine or white wine. Troches of hedychroi (i.e. compacted pills) were never completed since the recipe stated that it was not necessary. Instead, the ingredients of the troches were reduced to powder in a mortar and then mixed directly into the theriac. All eight classes where then finally mixed into honey, which was kept warm at about 50 °C and, after thorough mixing, balsam of Peru and red ochre were finally added. Each ingredient in the final theriac andromachalis amounts to between 0.1 and 1.3 per cent of the final composition, whereas the ingredients in troches of hedychroi constitute between 0.02 and 0.24 per cent of the final composition. Honey, the main ingredient, makes up 75 per cent of the total weight and the other solid and liquid components make up the remaining 25 per cent. The product is a rather compact dark brown and sticky paste which produced a slight bubbling during the first weeks.

But this prosaic description of the making of theriac leaves out the most important parts of the experience. It begins when one obtains the ingredients and stacks them up in a small room full of containers of fresh and fragrant Chinese medical rhubarb, gentian root, myrrh, aloe, cubeb pepper, marjoram, saffron and other herbal drugs and spices of the early modern pharmacopoeia. Simply by entering such a room one becomes immediately aware of the powerful, sensory aspect of early modern medicine. When handled, each of these substances makes its presence known. Some odours, such as of cinnamon and saffron, are familiar and set in motion familiar trains of thoughts and associations. Others seem, at least at the outset, completely alien or just vaguely unfamiliar. But as they are handled their scents become more recognizable. They become associated with the space where they are kept, and with the practices by which they are handled.

To compose theriac means that one deepens sensory appreciation of substances. These sensory experiences were not only a rewarding part of our efforts to make early modern medicines. Handling substances also gave viable explanations to written accounts about pharmaceutical practice. This ranged from the obvious to the subtle. Among obvious conclusions is that 'grinding work' is not only a metaphor. Grinding is indeed heavy and boring labour. Able-bodied servants and apprentices were of course almost always at hand in early modern pharmacies, and oftentimes we, too, longed for able-bodied assistants. Among more subtle insights was that the troches of agarikon probably were an answer to work environment problems due to dust formation when grinding. These troches, or lozenges, were to be prepared in advance by grinding agarikon, mixing the powdered substance with white wine, and then forming the agarikon and wine paste into lozenges. Agarikon, when ground in a mortar, raises a great amount of irritating dust, which tends to stick to surfaces. This would be difficult to handle, and to clean up, every time agarikon is called for in a recipe. Hence it makes sense to prepare the agarikon in advance. (The lozenges do not produce dust when ground.) Similarly, we learned which substances, in particularly resins, are sticky and hence difficult to handle and retrieve when put on the scales or in the mortar. But we still have not learnt what must have been an important skill, namely the trick of how to transfer sticky resins to and from containers and scales in precise quantities without losing a small quantity of substance. This is a small problem today, as substances are rather cheap compared to other costs, such as

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salaries. But given the high cost of these substances during early modernity, it would probably have been considered excessive to do as we did, namely to use two spoons and rub off as much substance as possible with the other spoon repeatedly, and finally clean the residual substance sticking to them with hot water.[43]

It is an open question whether the use of white wine is a substitution, or simply a recognition of best and common practice. The *Pharmocopoeja Holmiensis* does not specify the colour of the wine, and Maranta (1576) also does not specify this. However, Maranta argues that the amount of wine should be kept down as much as possible. Hence a white wine seems to be preferrable as it makes it easy to clearly see – and hence dissolve – any remaining solid material during grinding and dissolution. The issue might seem unimportant, but it underpins our argument that the making of theriac constituted the skilful handling of qualities, and not a mechanical adding of precise quantities of substance: Maranta also states that if too much wine is used to dissolve the ingredient gums and resins, an additional amount of honey should also be added to keep the consistency right. This would indicate that a point of making theriac (at least according to Maranta) is to correctly ferment the honey, because if the mass does not ferment, the ingredient parts will not be integrated with each other. It also indicates that Maranta, author of one of the most popular treatises on theriac, does not think that the proportion of the ingredients is the most important factor behind the potency of the theriac. Rather, it is the skill of the apothecary in getting the consistency precisely right, and in not introducing too much volatile fluid (i.e. water and alcohol) that would leave the compound during fermentation.[44]

As substances are handled and become familiar, the body becomes familiar with the movements involved in doing pharmacy. We began to understand that the process of making theriac was what experimental archaeologists sometimes call a *chaîne opératoire*, ('operational sequence'), bodily gestures and actions applied to materials, but also a 'physical rendering of mental schemas learned through tradition'.[45] It was this work that made it increasingly obvious to us why, in historical medicine making, apothecaries and other medicine makers relied heavily on input gained from their own senses and bodily experience. Our sensory and bodily experience confirmed that it made good sense to let taste, odour and visual inspection play a part both in assessments of the pharmacological potential of ingredients, and in evaluations of the medicinal effect of finished medicines. This brought us to the question of how reliable assessing through taste, flavour and odour could have been, and how reliably such experiences could be communicated among apothecaries (i.e. a gestural collective or community of practice).[46]

43 One might speculate that perhaps dirty spoons were washed out in tinctures (alcohol solutions) of the substance in question. Such tinctures would have been already present in the shop and could then have been topped up with an appropriate amount of alcohol. The importance of acknowledging 'thriftiness' in early modern knowledge practices has been argued by Simon Werrett, *Thrifty Science: Making the Most of Materials in the History of Experiment*, Chicago: The University of Chicago Press, 2019). See also Lucy J. Havard, 'Preserve or perish: food preservation practices in the early modern kitchen', *Notes and Records: The Royal Society Journal of the History of Science* (2020) 74, pp. 5–33. On 'tweaking' see Pugliano, op. cit. (2), pp. 249, 252, 272–3.

44 Maranta, op. cit. (37), pp. 10–12, 16, 18. It can be noted that it seems the *Holmiensis* hints at this problem too, by stating that one should hold back some of the honey, and only add it towards the very end. [Ziervogel] *Pharmacopoeja Holmiensis*, op. cit. (30), p. 52.

45 Jill Hilditch, 'Bringing the past to life: culture production and archaeological practice', in Dupré *et al.*, *Reconstruction*, op. cit. (7), pp. 63–89, 65–6.

46 We investigated this question in depth in Ahnfelt, Fors and Wendin, op. cit. (24). See also Sibum, 'Reworking' op. cit. (9), pp. 73–5, 83–5.

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We also learned that theriac andromachalis, as well as many of its component ingredients, tastes and smells powerful and often wonderful. This piece of fact tends to be omitted from historical descriptions and contemporary historical studies of theriac.

The sensory assessment

Early modern patients and physicians valued the sensory characteristics of medicines. The major Greek authorities – Plato, Aristotle and Galen – all discussed the nature of odour and agreed that odours affected the human body in important ways, and Aristotle noted that some odours had corresponding flavours. Medieval authors elaborated these theories connecting odours to bodily health. Odours were conceived as having material effects; as vapours they worked directly on the *pneuma* or the spirit of the human body and had a particularly powerful effect on the brain. Odours could, of course, be either beneficial or detrimental to health.[47]

Simultaneously, sensory information is notoriously difficult to transmit textually and today we know very little about the sensory characteristics of historic composite medicines. Given the importance attached to sensory evaluation by medical practitioners – from antiquity and well into the nineteenth century – this is a problematic lacuna in our knowledge of how historic actors perceived and used medicines. This part of our study approaches this problem by seeking to answer the question of how theriac can be construed as an object through linguistic description of its sensory qualities.[48]

We do this with recourse to modern methods of taste, flavour and odour assessment. There are many important reasons underlying this choice. First, the protocols used in food science aim to transfer sensory experience into standardized graphs and descriptions. This provides a means to transfer sensory impressions to the medium of print. Second, we use a modern protocol for safety reasons. Putting physiologically active substances, i.e. historically used medicines, in the mouths of people (such as students) is not something that historians should just start doing. There are many potential dangers, not just concerned with potential toxicity issues. Many of the substances used in historical pharmacy are, in the present day and age, rare or completely disused as medicines or foodstuffs, and test persons may not be expected to have come across them before trials. This means that it is a good idea to reduce exposure to a minimum in order to reduce the risk of harmful effects, such as allergic reactions. It is also absolutely necessary to have access to competence in pharmaceutical science as well as such protocols as have been developed in food science for the safe administration of foodstuffs. Experiments of this type are in fact experiments on human subjects. This implies that ethical rules must be followed. Safety considerations also present us with a further problem, from the authenticity point of view. Historically, theriac was usually taken in small quantities, either straight out of its container, or rolled into pills.[49] In order to reduce exposure, the theriac presented to the taste panel was dissolved in alcohol and strained before being assessed.

Solutions were made through extraction of the theriac using 40 per cent weight/volume ethanol (Absolut Vodka, Åhus, Sweden) to a content of 4 per cent w/v, in brown flasks with a glass stopper. Extraction commenced for one week at a temperature of approximately +10 °C

47 Katelynn Robinson, *The Sense of Smell in the Middle Ages: A Source of Certainty*, London: Routledge, 2021, pp. 3–5. See also Alain Corbin, *The Foul and the Fragrant: Odor and the French Social Imagination*, London: Picador, 1994; Saskia Klerk, 'The trouble with opium: taste, reason and experience in late Galenic pharmacology with special regard to the university of Leiden (1575–1625)', *Early Science and Medicine* (2014) 19(4), pp. 287–316; Mandelkern, op. cit. (20); Palmer, op. cit. (20), pp. 61–8. Shapin, op. cit. (20).

48 It should be noted that the sensory panel was given no information about the historical background, terms and categories discussed in the paper.

49 It could also be taken externally. Watson, op. cit. (1), pp. 62–3.

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and the flask was shaken every day for a few seconds. After filtration through a coffee paper filter the samples were prepared according to the following:

Odour samples for sensory analysis were prepared at 4 per cent (w/v) content. The samples were prepared by soaking a cotton pad with about five millilitres of test solution into an aluminium box (fifteen millilitres in volume) equipped with an aluminium screw-on lid.

Oral samples (taste and flavour) were prepared at 0.5 per cent (w/v) content and about five millilitres were taken into ten-millilitre brown glass flasks with aluminium stoppers.

Test samples were prepared at the Pharmacognosy Division, Department of Medicinal Chemistry, Uppsala University, Sweden, and transported by train to Kristianstad, Sweden, where sensory analysis was performed at the Department of Food and Meal Science, Faculty of Science, Kristianstad University. Test samples were stored in a refrigerator (+4 °C) upon arrival and accommodated to room temperature for one hour before sensory analysis. Reference samples were prepared in beakers with lids to help the sensory panel identify tastes and odours in the samples. The reference samples were: fresh lemon, fresh lemon peel, fresh ginger (minced), eucalyptus pastilles for managing cold (Vicks® Blue, extra strong, Procter and Gamble, USA), dry juniper berries (Kockens kryddor, Lyckeby Culinar, Sweden), fresh mint leaves, fresh grapefruit, fresh lime, clove and allspice (Kockens kryddor, Lyckeby Culinar, Sweden), Swedish Christmas non-alcoholic carbonated drink (Julmust, Apotekarnes, Sweden) and honey (Svensk Biodlarförening, Sweden) diluted in warm water. In addition to assessing theriac, the panel also assessed six simple substances on the same occasion. These were agarikon, zedoary, aloe ferox, saffron, myrrh and Chinese rhubarb root.[50]

The samples were analysed by a slightly modified version of the Flavour Profile Method® invented by Arthurs D. Little.[51] The modification consisted of the use of a scale running from zero to 100 instead of the shorter scale used in the original method. The sensory panel consisted of eight assessors who were selected and trained according to ISO Standard 8586-2:2008, meaning that they were selected due to having highly sensitive senses of taste and olfaction.[52] Before assessing the samples, they rehearsed how to perform testing and how to judge intensity on a numerical intensity scale, running from zero to 100. References and a few selected odour test sample extracts were assessed until consensus was reached before the main assessing of the ingredients took place.

The assessors were instructed to identify and describe the sensory attributes, taste, flavour and odour, in each test sample until consensus was reached upon a definition for each attribute. Then each attribute was assessed using the intensity scale. The assessors were instructed to use the full length of the scale to distinguish between samples which only slightly differed from each other. Each assessor needed to agree upon the placement of each attribute along the intensity axis. Between each sample the sensory panel had a break for ten minutes to refresh their senses. The assessors were instructed to use water and neutral wafers to clean their palate and neutralize their senses. The assessors were informed not to swallow the samples and to spit out right after assessment. Further, before agreeing to join the assessments, the panelists were informed about the samples and their potential as pharmaceutical ingredients using information from a standard textbook in pharmacognosy.[53]

50 See Ahnfelt, Fors and Wendin, op. cit. (24).

51 Heymann H. Lawless, *Sensory Evaluation of Food: Principles and Practices*, 2nd edn, New York: Springer, 2010.

52 ISO standard 8586-2:2008: Sensory analysis – General guidance for the selection, training and monitoring of assessors – Part 2: Expert sensory assessors.

53 C.E. Evans, *Trease and Evans Pharmacognosy*, 16th edn, Edinburgh: Elsevier, 2009.

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Following the rules for informed consent, each assessor signed for participation after being informed about the products and the terms of participation, which meant voluntary participation, freedom to leave the test without giving a reason, the right to decline to answer specific questions and an assurance that their participation would not affect their future treatment in the healthcare system in any way.

Results of the assay

The results show that theriac andromachalis was considered to have a rich and specific odour and oral profile. The perceived odours are described in Table 3 and the tastes and flavours in Table 4.

Christmas spices, bitterness and sweetness are the most profound tastes in the assessed composition (Figure 2). Bitterness was an important feature when assessing potential herbals as medicine already in ancient pharmacology and early modern medicine. According to Linnaeus, bitter substances were important in medicines as well as sweet substances like honey.[54] Honey is by far the main ingredient and sweet constituent in theriac and does indeed have possible beneficial medicinal properties. Honey acted not only as sweetener, but also as preservative, and recent studies suggest that fresh honey may have powerful antibiotic properties. However, as it is primarily fresh honey which has been shown to have antibacterial properties, it cannot be ascertained whether these properties would have carried over to a theriac in which the honey has fermented for several years.[55]

Discussion

Early moderns who made theriac andromachalis sought to reconstruct a valuable medicament from the distant past. Their goal was perfectly feasible at the time: to draw on well-known classical sources and knowledge to re-create what they believed was an effective antidote, which could possibly even be a cure for plague. Our goals are, of course, different. In the first part of the study, we established that theriac is, and was, a bundle, a complex temporal and spatial entanglement which goes under the name of a thing or object. In the second part of the study, we reworked theriac, by going through the gestures of identifying, finding and collecting materials, and combining them in the laboratory following a recipe. In the third part of the study, we subjected our theriac to sensory analysis, thus examining a set of the action that it produces, i.e. the agency of a sample of theriac on the senses. We established that the making of theriac involves handling and making judgements about a great number of substances with powerful smell and taste. We also learned that theriac does indeed have a rich and specific odour and oral profile. It is a product which can be both recognized and reliably assessed on the criteria of its taste, flavour and odour.

Unlike early moderns we modern reworkers who subject our products to test panels are not on the lookout for medical effects (rather, we try to avoid them). Our aim is to

54 Carl Linnaeus, *Clavis Medicinae Duplex: The Two Keys of Medicine, From a Swedish Translation Introduction and Commentary by Bergh B., Broberg G, Jonsell B.*, London: Whitby, 2012.

55 Fermented honey produces gas bubbles, a phenomenon associated with successfully manufactured theriac. Further signs of fermentation in honey are characteristic odour, increasing acid flavour and gas bubbles. C.M. Carvalho, S. Meirinho, M.L.F. Estevinho and A. Choupina, 'Yeast species associated with honey: different identification methods', *Archivos de Zootecnia* (2010) 59, pp. 103–13, 104. On honey's medical use, traditionally and presently, see Y. Bellik and L. Boukraa, 'Honey: an ethnomedicine', in L. Boukra (ed.), *Honey in Traditional and Modern Medicine*, Boca Raton: CRC Press, 2013, pp. 1–12; S. Aissat, A. Kesic, H. Benbarek and A. Meslem, 'Honey-based formulations and drug purposes', in Boukra, op. cit., pp. 279–332; T.C. Olofsson and A.Vasquez, 'Detection and identification of a novel lactic acid bacterial flora within the honey stomach of the honeybee *Apis mellifera*', *Current Microbiology* (2008) 57, pp. 356–63.

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Table 3. Odour attributes and definitions.

Attribute	Definition
Grapefruit	Grapefruit with hints of Seville orange, blood orange and other citrus
Ginger	Specific trigeminal
Honey	Honey wax
Vanilla	
Christmas spices	Blend of cardamom, clove and saffron
Wormwood	
Camphor	Minty and menthol-like
Wet firewood	Firewood found on the beach
Green dry spices	Blend of oregano, thyme, estragon and sage

Table 4. Oral attributes and definitions.

Attribute	Definition
Taste	
Sweet	Sweet taste
Bitter	Bitter taste
Flavour	
Christmas spices	Blend of cardamom, clove and saffron
Coke candy	Soft candy flavoured with coke, fruits
Violet	Flower, mainly violet
Seville orange	Old English marmalade
Liqourice root	Barky liquorice
Camphor	Minty and menthol-like

learn how theriac acts back on the body of its maker, and on the senses of its consumer. Thus we have argued the case for reworking as the primary goal of the material production process. We do not use the terms 'replication', 'reconstruction' or even 'reproducing' since we have focused on the process, the road, rather than on an imaginary goal. We considered how the various ingredients of theriac reacted to and resisted our efforts to reshape them and work them into our product. This has led us to a greater appreciation of the apothecary's craft, and a greater understanding of traditional methods for handling materials (such as pounding).

Reworking theriac may in some regards be seen as operationalizing anthropologist Tim Ingold's understanding of making.[56] Procuring the great number of ingredient plant, animal and mineral substances constitutes indeed the handling of a current of material

56 Drawing on phenomenology, Ingold asserts with Henri Bergson that 'the very permanence of … form is only the outline of a movement'. Bergson quoted in Ingold, op. cit. (15), p. 12. However, this is not the place to discuss the deeper philosophical implications of Ingold's position.

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Figure 1. Odour profile of theriac andromachalis.

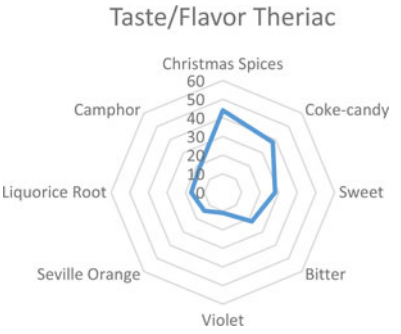

Figure 2. Taste and flavour profile of theriac andromachalis.

flows. The process of bringing them together requires skillful working together of 'materials, bodily gestures and the flows of sensory experience' – a process which is indeed rather akin to weaving. And theriac is not a closed object, but a bundle, consisting not only of ingredients, but also of methodologies, recipes, historical references and consumer expectations. It is a bundle which is difficult to bring together, and which may also easily fall apart. We swim, says Ingold, in a world of materials in constant motion and by engaging directly with materials we learn more about them and discover that materials are active. This notion of active materials is key to his approach. Things are not merely acted upon but have the capacity to act back.[57]

For the purposes of this study, the first lesson to be learnt about how materials act back is that they provide constraints, and that these constraints are historically contingent. Reworkers accept this and do not aim to make perfect copies. Rather, they let themselves be led and guided by the availability of materials and try to learn from constraints. Hence the reworking framework permits us to treat substitution as a creative process, which enriches the historical insights gained from the manufacture of historical medicaments. Thus substitution does not undermine the 'authenticity' of the product. It becomes a means to a further end, namely to understand why historic medicine makers did what they did, to gain deeper historical insights rather than produce copies. While early moderns were forced to substitute balsam of Judea with a contemporary product, we chose to substitute the protected European adder due to environmental/conservationist concerns. This is not a whimsical choice, but a methodological consequence of reworking within the framework of experimental history of science. As reworkers, we are experimentalists, investigating process, not product. We are also not stage magicians: it is important to

57 As Ingold argues, the notion that material objects do not have agency arises from the mental operation of imagining materials as inside closed objects. These objects, in turn, are conceived as no longer a part of the currents of circulating materials of which they are composed. Ingold, op. cit. (15), pp. 16–17, 20, 28.

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us that we do not create the illusion that we have made an early modern theriac. Our use of frog's legs instead of viper sends an important signal about this: one cannot re-create or reconstruct the past and should not pretend to do so. Here, the spatial framing is useful: One can visit Rome and see the sights, but one cannot visit the Rome of Emperor Augustus. One can stage a scene from imperial Rome in a movie set, write long books about it, role-play it, and so on and so forth. But the actual site of imperial Rome is inaccessible to us. As it is with Rome, so it is with theriac andromachalis. We are not early moderns and the materials available to us are not early modern medicinal simples. They do not carry the same meanings and associations, and they have not been produced, harvested, preserved and traded using early modern methods.[58] Hence, they are similar in some ways, but different in many others. From this follows one of our main conclusions as experimental reworkers: that the process of making theriac may be used to learn more about early modern history, but to be concerned about its authenticity is to misconprehend the nature of the product.

The second lesson is that our process-oriented approach led us into unknown places. This particularly involved the appreciation of the sensory qualities of medicinal substances, and consequently led to sensory analysis. Again, Ingold, who in turn draws heavily on phenomenology, can help us to frame this insight theoretically, as he seeks to draw our attention away from material properties, and towards qualities, such as taste and flavour, and qualitative knowledge borne out of sensory perception and practical engagement.[59] As in our previous work, we emphasize in this paper the importance of taste and smell to the early modern apothecary's craft.[60] Apothecaries would, presumably, have inspected and tasted several different samples of theriac before attempting to make their own, or more likely have made their first attempts as assistants to a master with previous experience. At the end of the manufacturing process the theriac would have been handed over to patients and physicians, who would have made their own assessment of the product. Was this a good and powerful theriac, or was it a bad and weak one? Customers (particularly physicians), too, had previous experience and were likely to have tasted a variety of theriacs prepared by different apothecaries. Hence the flavour and odour of theriac were part of a sensory regime which is now lost to us, but which was once culturally shared and agreed, and subject to innovation and negotiation.

In conducting the work underlying the paper we have used methodologies from food science and brought them into the history of science and medicine, with the aim of creating a method to conduct sensory assessment of historic medicaments. As we have explained, the ways in which medicaments act back make them difficult to experience in a safe way. Our experiment, which was conducted on a product which had been, so to speak, emptied of physiological and medical effects, does not really comprise an early modern experience of theriac, but a safe and ethical contemporary re-enactment/reworking of certain aspects of the experience of taking theriac. And although we have accessed and described unknown tastes, flavours and odours, our conclusions do not revolve around the taste, flavour and odour of the past. Our work has merely established that our sample of theriac has a powerful, interesting and pleasant taste, odour and flavour. But this answer does go some way towards answering the question, did it work, and how?

Our answer is yes, we now know that theriac 'worked' on the senses. Given its content of physiologically active substances (not present in our sample) we can also conclude that theriac probably had deeper physiological effects. But at this point we cannot say anything about whether it functioned as a general antidote or panacea due to its content

58 Ahnfelt, Fors and Wendin, op. cit. (24), pp. 425–8.
59 Ingold, op. cit. (15), p. 29, 32.
60 Ahnfelt, Fors and Wendin, op. cit. (24), p. 427–8.

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of organic molecules and other chemical compounds. Instead, as our main conclusion from this part of the study we wish to make the case for an incommensurability between an understanding of medicines as chemical compounds and an early modern understanding which proceeded from sensory assessment.

The ethnopharmacological approach to historical medicaments is a lively research tradition which seeks to investigate how historical drugs may be used for contemporary medical purposes.[61] Although we greatly respect the discipline, we would like to politely push back at certain of its research strands and assumptions. There are two recent studies of theriac, conducted as literature reviews, that make conjectures about medical effect on the basis of the biological actions of ingredient substances as described in pharmacological literature.[62] Theriac, however, is not reproduced and tried out, and the question of fermentation is not properly addressed. The approach to theriac by way of a review of the current research literature on its ingredients is also problematic. Most ingredients of theriac have a very long history of traditional use. Consequently, the contemporary scientific literature on these ingredients is overwhelming. For example, a search on 'saffron' in PubMed (accessed 23 August 2021) yields 2,106 results. Allowing for seventy-three simple substance ingredients in theriac, it becomes immediately apparent that it is almost impossible to draw conclusions on the medicinal effects of theriac based on a meta-study discussing the combined effect of ingredient substances. The question of fermentation is also important. As soon as ingredients are mixed with each other, the ingredient molecular compounds begin to degrade and recombine through fermentation and other processes. Historical sources indicate that this process plays a key role in the efficacy of theriac. Indeed, theriac is supposed to ferment for at least five years before it is used.[63] This, of course, means that what goes into the mixture is not what comes out several years later. For these reasons, only an analysis of compounds present in the final product would yield information about the possible physiological and medical effects (in the modern sense) of theriac. We will not be able to provide such a study in the present paper, but promise to return with one in a few years, when our stored samples of theriac have matured.

We include this discussion of ethnopharmacology to emphasize that modern medical interpretations of historical medicaments must be made with great caution. The approaches of contemporary pharmacology do not easily translate to the study of historic polypharmacy. It is also a problem that modern medical interpretations tend to seep into works written by historians. A typical statement from a recent book is the following:

> A modern pharmacological analysis of the ingredients of Mithridatum as given by the earliest (Roman) sources suggests that, while most of the ingredients function as aromatics, several ingredients also help to reduce an inflammatory response to poison, including cinnamon and saffron.[64]

61 Jan G. Bruhn and Laurent Rivier, 'Ethnopharmacology: a journal, a definition and a society', *Journal of Ethnopharmacology* (2019) 242, pp. 1–6. See also T.J. Motley, 'Techniques: bioprospecting historical herbal texts by hunting for new leads in old tomes', *Trends in Pharmacological Sciences* (2004) 25, pp. 494–8. Sarah E. Nelson, 'Persephone's seeds: abortifacients and contraceptives in ancient Greek medicine and their recent scientific appraisal', *Pharmacy in History* (2009) 51(2), pp. 57–69.

62 Mohd Aleem, Imran Khan, Mohd Danish and Ajaz Ahmad, 'History and traditional uses of tiryaq (theriac): an important formulation in Unani medicine', *Journal of Phytopharmacology* (2020) 9(6), pp. 429–32. Danuta Raj, Katarzyna Pękacka-Falkowska, Maciej Włodarczyk and Jakub Węglorz, 'The real theriac: panacea, poisonous drug or quackery?', *Journal of Ethnopharmacology* (2021, preprint), at https://doi.org/10.1016/j.jep.2021.114535.

63 Watson, op. cit. (1), pp. 49–50, 77–8.

64 Gibbs, op. cit. (2), p. 12.

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In our view this is not the proper way to answer the big question 'Did it work?' Our study's answer to the question is, no, it probably did not work as claimed. Especially so if historic statements about theriac's effects are interpreted from the point of view of contemporary medicine. But theriac did produce powerful sensations, and maybe some significant physiological effects too. Hence it worked in several important early modern senses. This becomes evident when one proceeds to study medicaments from the point of view of bodily experience, rather than that of ingredient molecules.

Let us now return to the notion that the making of theriac was a *chaîne opératoire*, i.e. bodily gestures and actions applied to materials, which were part of a wider pharmaceutical tradition, a culture of making and doing. As the procedure fully engaged the theriac makers' discerning senses, it becomes apparent why historical pharmacy was so tightly connected to the spice trade, as well as to the manufacture of liqueurs, spiced wine and candy. Not so much a scientist or technician (making precision measurements with his scale and assembling precise quantities of substances to order) as we might imagine, the historical apothecary may perhaps better be compared to a winemaker or chocolatier, aiming to create a high-quality product with a consistent smell, taste, colour and texture. Another comparison would be to that of the musician.[65] Using the recipe as their music score, such an apothecary would have been aware that they needed to be true to the original, while each composed medicine also invariably would become a unique piece, a product of context, audience and ingredients at hand. And he would have combined taste, odour and texture in such a way as to maximize sensory and bodily impact.

Such an interpretation is consistent with what we know about humoral pathology, the medical theory at the heart of medieval and early modern medical culture. For humoral pathology, the main point of medical treatment was to rebalance the humours. This was achieved by creating bodily reactions in the patients, such as the experience of sensation, but also sweating, vomiting and evacuation. Early moderns assumed a connective interplay between the physiological changes that bodies undergo when they ingest substances, and the sensory impressions that the subjects have and convey. This is because self-trial, and observations of others who ingested substances, were the main means of comprehending the effects of medicaments. Taste, furthermore, was the main indicator of which bodily reaction one could expect. The role in this healing regime of the sensation of ingesting medicaments has remained largely unexplored. It may be that we have misconstrued the nature of early modern pharmaceutical expertise. Perhaps apothecaries were not the masters of precision scales, ingredients and recipes, but of odour, taste, flavour and mouthfeel.

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65 Hans Fidom, 'Making musicians think: the problem with organs', in Dupré *et al.*, *Reconstruction*, op. cit. (7), pp. 91–114. Arguably, reworkers of historic medicines should find inspiration in musicians who perform historic music. Rather than aiming to make copies of one or another imagined ideal medicine of the past, we should instead try to make available historically informed experience of medicine, which may inspire further reworking (ibid., p. 100).

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