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An Empirical Study of Cultural Evolution: The Development of European Cookery from Medieval to Modern Times

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Abstract

We have carried out an empirical study of long-term change in European cookery to test if the development of this cultural phenomenon matches a general hypothesis about cultural evolution: that human cultural change is characterized by cumulativity. Data from seven cookery books, evenly spaced across time, the oldest one written in medieval times (~1200) and the most recent one dating from late modernity (1999), were compared. Ten recipes from each of three categories ('poultry recipes', 'fish recipes,' and 'meat recipes') were arbitrarily selected from each cookery book by selecting the first ten recipes in each category, and the numbers (per recipe) of steps, separate partial processes, methods, ingredients, semi-manufactured ingredients, compound semi-manufactured ingredients (defined as semi-manufactured ingredients containing no less than two raw products), and self-made semi-manufactured ingredients were counted. Regression analyses were used to quantitatively compare the cookery from different ages. We found a significant increase in the numbers (per recipe) of steps, separate partial processes, methods, ingredients, and semi-manufactured ingredients. These significant increases enabled us to identify the development of cookery as an example of the general trend of cumulativity in long-term cultural evolution. The number of self-made semi-manufactured ingredients per recipe, however, tended to

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decrease over time, which may reflect the cumulative characteristics of cultural evolution at the level of society, considering the accumulation of knowledge that is required to industrialize food production.

Introduction

Humans are not the only animal to have culture, transmitting knowledge socially from one generation to the next (Avital and Jablonka 2001; Laland and Hoppit 2003; Levebre and Palameta 1988; Whiten et al. 1999). However, human culture is unique in many respects. For example, one of its hallmarks is that it is cumulative, with cultural information accumulating over generations (Boyd and Richerson 1996; Enquist et al. 2008; Sahlins 1960; Tomasello 1999; Caldwell and Millen 2008; 2010), whereas no accumulation of socially transmitted knowledge has been found in animal cultures (Boyd and Richerson 1996; Tomasello et al. 1993).

Three different but related concepts have been proposed as measures of this cumulativity (Enquist et al. 2008): (1) the *efficiency* of a given cultural trait may improve over time as a consequence of accumulation of knowledge, (2) the *amount* of culture may grow in some countable way, and, (3) the *complexity* of a specific cultural trait may increase (see also Derex et al. 2013; Kline and Boyd 2010; Perreault et al. 2013). For example, the number of tools in a carpenter's tool kit presumably increases the carpenter's efficiency in building as well as the complexity of learning carpentry. Note, however, that a *decrease* in efficiency, amount, and/or complexity is also a possibility within cultural evolution (e.g., Henrich 2004; Tennie et al. 2014).

The increasing *amount* of culture has been established empirically with regard to different cultural traits. For example, Lehman (1947) identified exponential increases in the numbers of contributions within different academic subjects, as well as in the numbers of grand operas and orchestral pieces. Further, Darmstaedter and Du Bois-Reymond (1904) found that the speed of scientific discoveries has increased over the last 1000 years, and, more recently, Buchanan et al. (2011) documented an increase in the number of patents over time. That cultural *complexity* has increased is hard to dispute, but *efficiency* is harder to measure. However, agricultural production of food per unit land is a well-documented example of increased efficiency, as is industrial productivity per worker through mechanization.

The art of cooking is especially interesting in a cultural evolutionary context for several reasons: it relates to a basic human need—eating—but differences in expression can be assumed to be reasonably free of biological constraints. The list of items historically considered as foods is truly massive (Davidson 1999; Eidlitz 1971; Kiple and Ornelas 2000). It is through this capacity for dietary diversity that

humans are the only mammal in our size-range that have managed to colonize almost every environment on the planet. Nevertheless, humans typically do not eat everything edible in their environment at any specific time or place, not even in the face of famine. On the contrary, habits and procedures connected to food have a pronounced cultural basis. Thus, the diversity of culinary arts is considerable.

There exist several earlier studies on changes in food culture, from different and sometimes opposing perspectives (e.g. Harris 1987; Lentz 1991). Most of more recent research is focused on particular aspects, such as gender (Neuhaus 2003; Sobal 2005), emotions (Locher et al. 2005), or ethnic identity (Searles 2002), but there also exist examples of studies concerned with general change (e.g., Isaksson 2009; Isaksson et al. 2015). When evolution is included in the study, the focus is usually on biology (Crittenden 2011) rather than culture. Here, however, our research interests concern patterns of cultural change. Cookery books are valuable as source material for such an analysis because the genre has a reasonably long history, and recipes are suitable for a systematic, comparative approach. The value of recipe collections for the study of short-term changes in modern cookery books has already been shown elsewhere (e.g., Symons 2009).

To study the evolution of cookery, we developed and tested an extraction method that facilitates the application of statistical analyses (see Materials and Methods and the Supplementary Materials). We then used this extracted data to study changes in seven different variables: the number (per recipe) of steps, separate partial processes, methods, ingredients, semi-manufactured ingredients (defined as prepared ingredients containing one or more raw products), compound semi-manufactured ingredients (defined as semi-manufactured ingredients containing no less than two raw products), and self-made semi-manufactured ingredients. Thus, according to a simple definition of the concept of complexity, that greater amounts of diverse components linked through more interconnections result in more complexity (see also Caldwell and Millen 2008; 2010), increases in the first six variables add to the complexity of the prepared dishes, and, hence, reflect an increase in the complexity of cookery over time. The last-mentioned variable, the number of *self-made* semi-manufactured ingredients, is interesting from another point of view: An increased or decreased number of self-made semi-manufactured ingredients does not reflect an increased or decreased level of complexity of the dishes (*who* made the semi-manufactured ingredient is irrelevant). However, a change in this variable would reflect societal changes and might reveal cumulativity of knowledge at the level of society.

Materials and methods

Selection of cookery books

We selected European books as our focus because of the comparatively rich material from this region and their relative ease of access. To limit the extent of our study, we chose to focus on northwestern Europe in general and Scandinavia in particular. We have strived to choose books that were in actual use and tried to get a fairly even chronological distribution across time. For the older books, we did not have much choice because the books chosen represent the only, or one of very few, translated surviving cookery manuscripts. The more modern books were chosen based on their popularity—there are thousands of modern cookery books, a fact that makes our selection of contemporary books somewhat arbitrary.

The collection *Libellus de Arte Coquinaria* (*The Little Book of Culinary Arts*) was included in the study because it is the oldest preserved medieval manuscript describing cookery. It was most likely composed in the first half of the 13th century, and is preserved as a family of four related manuscripts written in Old Danish, Icelandic, and Low German, but it is probably based on a somewhat earlier, possibly French, manuscript (Grewe and Hieatt 2001). It is a small collection, containing only 35 recipes.

The *Forme of Cury* (*Forms of Cooking*; Hieatt and Butler 1985) was chosen as another representative of medieval cookery books. It is a collection of some 250 recipes from the 14th century. The author is given as 'the chief Master Cook of King Richard II.' Thus, this book is an example of a recipe collection written by a professional cook in an aristocratic setting.

From the 17th century, we selected the anonymous *Een Lijten Kockebook* (*A Small Cookery Book*), published in 1650 (Wahlund 1990). It is probably compiled from original German recipes and describes comparatively homely cooking.

Of the 18th century's 'housekeeping books' (a common type of cookery book from this century, characterized by instructions for much more than cooking), we chose *Märta Stures Hushållsbok* (*Märta Sture's Book of Housekeeping*; Wikström 2007), written by a Swedish governor, Gustaf Abraham Piper, as a gift to his young wife, Märta Sture in 1739. It contains 368 recipes.

From the late 19th century we have chosen C. E. Hagdahl's *Kok-konsten som Vetenskap och Konst* (*Cookery as Science and Art*; Hagdahl 2004), because it has been characterized as the book that introduced Sweden to modern cooking. With its 3000 recipes, it is a wide-ranging summary of European culinary arts of the time, including new thinking in relation to the physiology of nutrition. The author revels lustfully in the art of cooking, and the book is aimed at food-interested persons from all societal classes.

From the 20th century, we chose two classic Swedish cookery books: *Kajsas Kokbok* (*Kajsa's Cookery Book*; Fransén et al. 1976) and *Vår Kokbok* (*Our Cookery Book*; Andrews and Lindgren 1999). *Kajsas Kokbok* was first published in the 1930s, but we chose the 24th edition, from 1976, for the study. Originally, it had the subtitle '*a cookery book for the country household,*' and it was chosen because it bridges the change into the late modern era represented by the 24th edition of *Vår Kokbok*, from 1999. *Vår Kokbok* was published by the Swedish cooperative society, and was aimed at a broad audience: It was written in a simple, understandable style and illustrates a late-modern, fairly urbanized cooking style. Both of these cookery books contain hundreds of recipes.

Data collection and coding of the recipes

Ten recipes from each of the categories ('poultry recipes,' 'fish recipes,' and 'meat recipes') were arbitrarily selected from each cookery book by selecting the first ten recipes in each category when possible (in a few cases, there were less than ten recipes per category in a book). For each recipe, the number of steps in the preparation process, methods required, ingredients, semi-manufactured ingredients, compound semi-manufactured ingredients, and self-made semi-manufactured ingredients were counted. Moreover, the number of separate partial processes was counted. To do that, each recipe was coded according to a system described in the Supplementary Materials. In addition to enabling the identification of separate partial processes, this coding made it possible to visualize each recipe in an informative manner, both when recipes were simple (Figure 1) or more complex (Figure 2). (Note that different partial processes are not necessarily regarded as equal.)

The same person (Envall) coded all recipes. Initially, all authors coded recipes until we agreed on the coding algorithms (see Supplementary Materials), but only those coded by Envall were used in the analyses. Every step in the process was coded, even those that were not explicitly described in the recipe, but rather implied, since it was *cookery*, not the descriptions (recipes) that we wanted to study. (For instance, if an ingredient shall be boiled according to the recipe, 'add water' was added to the coding, even though this action is not mentioned in the recipe.) To make the data from the different cookery books comparable despite the varying amount of implicit information and to prevent stylistic differences from impacting the results, additional directives were taken into account. These are described in the Supplementary Materials. In total, we coded 193 recipes from the seven cook books: 60 fish recipes, 65 meat recipes, and 69 poultry recipes.

Analyses

We carried out regression analyses out on the relationship between publication year and seven variables: the respective numbers per recipe of steps, separate partial processes, methods, ingredients, semi-manufactured ingredients, compound semi-manufactured ingredients, and self-made semi-manufactured ingredients. Statistical significance was set at $p \leq 0.05$.

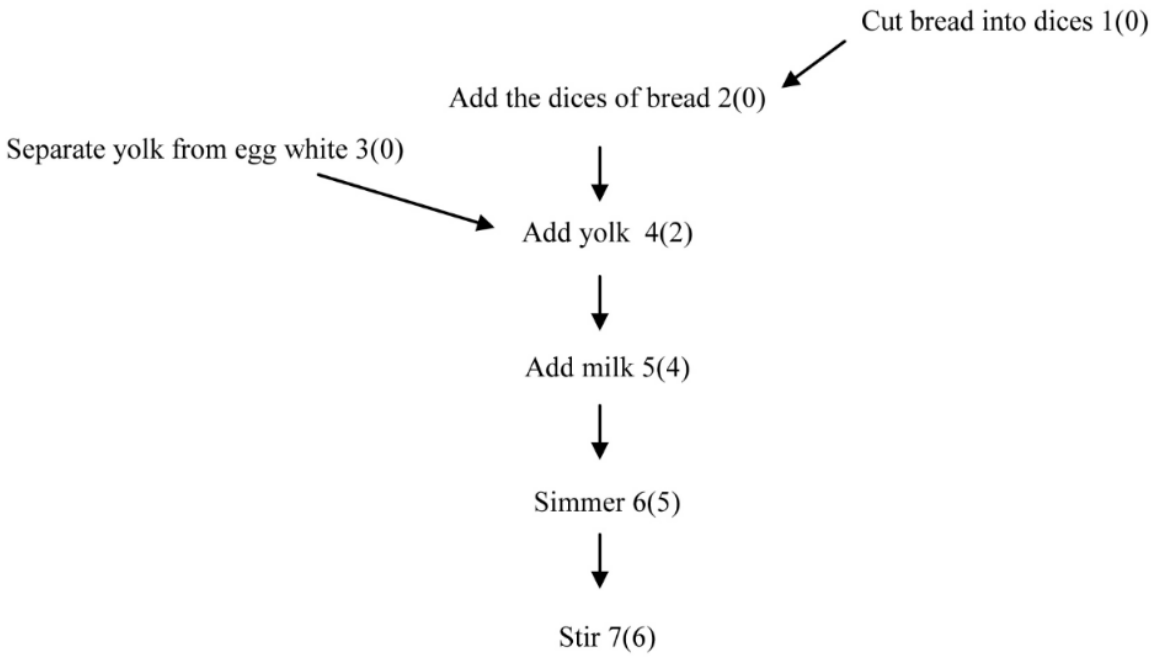

Figure 1. Visualization of the recipe for the dish *Kaliis* from *Libellus de Arte Coquinaria* (~ 1200). Numbers without brackets enumerate the nodes/steps; numbers within brackets indicate source node (see Supplementary Materials). Source node '0' indicates the beginning of a new partial process (see Supplementary Materials).

Results

We found that the number of steps per recipe has increased significantly over the last 800 years ($p<0.001$; $b=0.015$; $R^2=0.140$; about one step per 66.7 years, or 12 steps during the 800 year period studied). The same is true for the number of methods per recipe ($p<0.001$; $b=0.004$; $R^2=0.146$; about one method per 250 years, or 3.2 methods during the 800 year period studied) and for the number of separate partial processes per recipe ($p<0.001$; $b=0.004$; $R^2=0.160$; about one separate partial process per 250 years, or 3.2 separate partial processes during the 800 year period studied). Further, the number of ingredients per recipe has increased over time ($p<0.001$; $b=0.004$; $R^2=0.131$; about one ingredient per 250 years, or 3.2

ingredients during the 800 year period studied), and the same is true for the number of semi-manufactured ingredients per recipe ($p<0.001$; $b=0.003$; $R^2=0.120$; about one semi-manufactured ingredients per 333.3 years, or 2.4 semi-manufactured ingredients during the 800 year period studied) and for the number of compound semi-manufactured ingredients per recipe ($p<0.001$; $b=0.001$; $R^2=0.089$; about one compound semi-manufactured ingredients per 1000 years, or 0.8 compound semi-manufactured ingredients during the 800 year period studied). The number of self-made semi-manufactured ingredients per recipe, however, has tended to decrease over time ($p<0.071$; $b=-0.001$; $R^2=0.022$; about one self-made semi-manufactured ingredients per 1000 years, or 0.8 self-made semi-manufactured ingredients during the 800 year period studied) (Fig. 3).

All variables were highly correlated with one another ($p\leq0.001$), except for self-made semi-manufactured ingredients, which were not correlated with separate partial processes per recipe or the number of methods per recipe (Supplementary Materials, Table 1). In some cases, the high correlations are attributable to the fact that some variables are autocorrelated (e.g., if adding more ingredients will automatically increase the number of steps in a recipe), whereas in other cases, the high correlations indicate separate cultural evolutionary processes (e.g., the number of ingredients and the number of methods are not necessarily related).

The results were similar when we divided the recipes into three groups according to the main ingredient (poultry, meat, or fish), except for self-made semi-manufactured ingredients, which showed a significant decrease in fish recipes, but no change in poultry or meat recipes.

Discussion

Increased complexity of European cookery

Our results indicate an increase in the complexity of European cookery since medieval times, given the greater number of diverse components subjected to a greater number of operations, linked through a greater number of interconnections. We have identified increases in the numbers (per recipe) of steps, separate partial processes, methods, ingredients, semi-manufactured ingredients and compound semi-manufactured ingredients, respectively. Note, however, that the observations of an increased number of steps and separate partial processes are most certainly induced by an increasing number of methods and ingredients (Supplementary Materials, Table 1).

As outlined in the introduction, there are three different concepts that have been proposed as measures of cultural cumulativity: efficiency, amount, and complexity (Enquist et al. 2008 and references therein; see also Derex et al. 2013; Kline and Boyd 2010; Perreault et al. 2013). Here, we have documented an increase

in the *efficiency* of cooking through the increased use of semi-manufactured ingredients and compound semi-manufactured ingredients (see also Nyberg 1989). Further, an increase in the *amount* of culture is indicated through increases in the numbers (per recipe) of steps, partial processes, methods, and ingredients. Finally, all these documented increases taken together indicate an increase in the total *complexity* of cooking. Thus, cooking is a prime example of cultural cumulativity (Enquist et al. 2008; Caldwell and Millen 2008; 2010). The possibly least surprising increase is that in the number of ingredients per recipe; a growing global food market and the modern preservation and transport possibilities have most certainly contributed to this development. Note, however, that this increase reflects the number of ingredients *per recipe*, which also indicates the inclusion of more complex *mixtures* than before.

The general increase in the number of methods used per recipe might be surprising, given that new technical innovations have been introduced to simplify cooking (e.g., the food processor, the microwave oven, etc.). However, these have not replaced more traditional cooking; the innovations have rather been added to it. The new household technologies of the late 20th century have not decreased the time spent cooking as much as they have contributed to the increased variation in what we eat (Basalla 1988).

One variable was found to have decreased somewhat over time, albeit not significantly, except in fish recipes: the number of self-made semi-manufactured ingredients. Here, we can sense an influence of societal specialization in our results: semi-manufactured ingredients are, to an ever larger degree, bought rather than self-made. This trend may reflect the cumulative characteristics of cultural evolution at societal level.

Source critical problems

As with all written sources, there are source critical problems with which we have had to deal. First, many of the surviving early manuscripts are actually based on common earlier sources and are only different transcripts of the same originals. To contend with this issue, we have relied on the work of other scholars analyzing these texts. Further, the contexts of production of the cookery books have certainly changed over time. Most of the earlier cookery books are written in feudal aristocratic or even royal settings, whereas many of the more recent ones are intended for the broad public. Such a pattern might suggest a bias of more advanced cooking represented in the early cookery books than in the later ones, but note that this bias runs contrary to our findings of increased cultural complexity over time. Our results point to an increase in the level of complexity of cookery despite this bias.

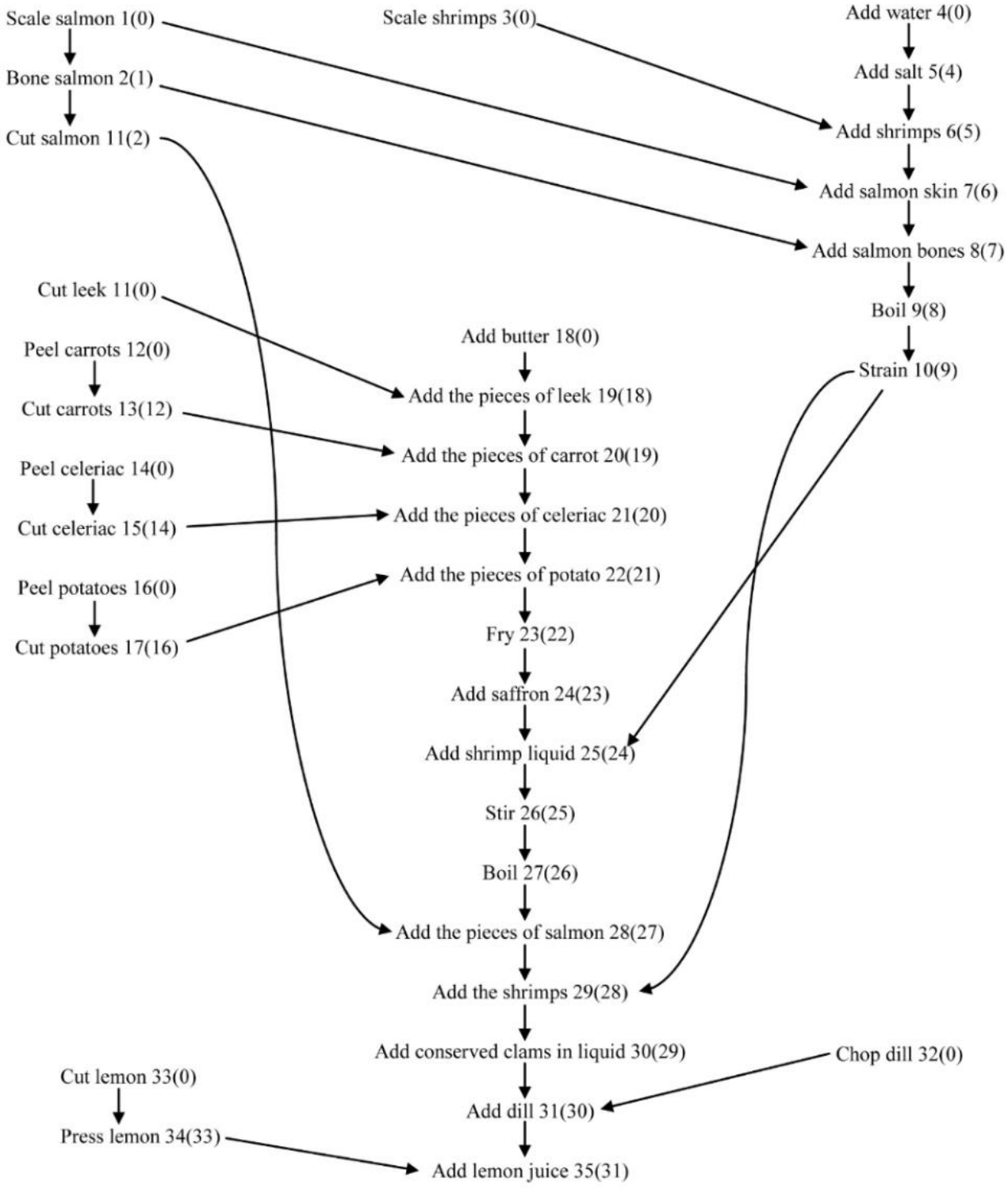

Figure 2. Visualization of the recipe *Fisksoppa Till Fest* (Fish soup for parties) from *Vår Kokbok* (1999). Numbers without brackets enumerate the nodes/steps; numbers within brackets indicate source node (see Supplementary Materials). Source node '0' indicates the beginning of a new partial process (see Supplementary Materials).

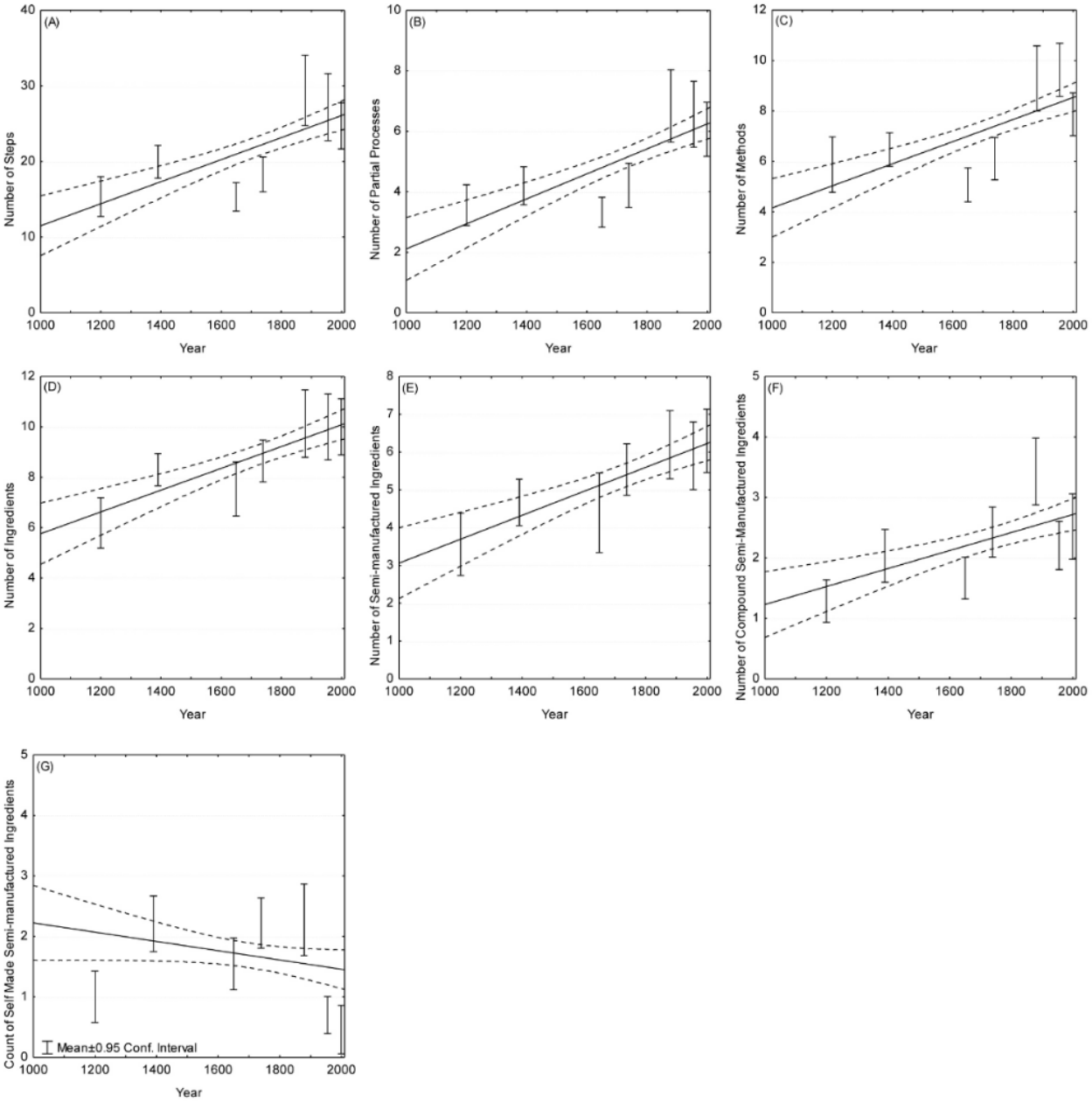

Figure 3. Changes of the respective variables over time. The number (per recipe) of (A) steps, (B) partial processes, (C) methods, (D) ingredients, (E) semi-manufactured ingredients, and (F) compound semi-manufactured ingredients have all increased significantly over time, whereas the number per recipe of (G) self-made semi-manufactured ingredients per recipe has decreased somewhat. The solid line indicates the regression line with 95% confidence interval for the slope given by the dashed lines. The whiskers show the average and 95% confidence interval for the mean value of each cookery book.

There also exist textual differences that may be problematic. Some of the recipes are short notes from memory, whereas others are immensely elaborate, describing every single step in the process. However, it is the cooking—the actual preparation procedure—that has been investigated in this study, not the recipes. To circumvent this problem we included all implicit steps in the coding (as described under Materials and Methods). We have also taken the directives described in the Supplementary Materials into consideration to avoid such text-induced biases.

Models of cultural evolution

There now exists a number of models of cultural evolution (e.g., Carneiro 2003; Cavalli-Sforza and Feldman 1981; Durham 2001; Galtung and Inayatullah 1997; Ghirlanda and Enquist 2007; Laland and Brown 2002; Boyd and Richersen 1985). Many current models are mainly focused on the transmission of cultural traits (Caldwell and Millen 2010; Durham 2001; Boyd and Richerson 1989; Ogburn 1950). However, the model of Enquist et al. (2008) highlights the fact that it is insufficient with cultural transmission to understand why cultural elements accumulate over time; a constant influx of novel ideas is of central importance. Ogburn (1950) and Ogburn and Nimoff (1958) point out that accumulation occurs when the rate of gains of cultural elements outnumber the number of losses, and also note that innovations often are generated by combining pre-existing cultural traits in novel ways, which results in the prediction that the number of innovations should increase with time as more and more cultural elements become available from which to build novel inventions. Further, Henrich (2004) has modeled how population size and mechanisms of social learning interact in a way that predicts a relationship between population size and the amount of cultural traits: larger populations are able to maintain more cultural elements. Our results confirm the importance of an increasing innovation rate as the number of novel methods and ingredients increase over time, in turn resulting in an increased number of steps and processes per recipe.

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