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'It's like having a physician in your pocket!' A critical analysis of self-diagnosis smartphone apps

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ABSTRACT

More than 100,000 mobile phone software applications ('apps') have been designed for the dissemination of health and medical information and healthcare and public health initiatives. This article presents a critical analysis of self-diagnosis smartphone apps directed at lay people that were available on the Apple App Store and Google Play in mid-April 2014. The objective of the analysis is to contribute to the sociology of diagnosis and to critical digital health studies by investigating the phenomenon of digitised diagnosis via apps. We adopted a perspective that views apps as sociocultural artefacts. Our analysis of self-diagnosis apps suggests that they inhabit a contested and ambiguous site of meaning and practice. We found that app developers combined claims to medical expertise in conjunction with appeals to algorithmic authority to promote their apps to potential users. While the developers also used appeals to patient engagement as part of their promotional efforts, these were undermined by routine disclaimers that users should seek medical advice to effect a diagnosis. More research is required to investigate how lay people are negotiating the use of these apps, the implications for privacy of their personal data and the possible effects on the doctor–patient relationship and medical authority in relation to diagnosis.

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1. Introduction

Mobile software applications ('apps') have become an important element of smartphone and tablet computer use since their emergence in 2008. Millions of apps designed for smartphones, tablet computers and other mobile devices have been developed since their first appearance. The two largest app stores by far, Google Play and the Apple App Store, both offered over a million apps each by mid-2014 (1.3 million for Google and 1.2 million for Apple) (Stastista, 2014). Medical and health apps constitute a major part of this market. (Both the Apple App Store and Google Play allow developers to categorise their apps in pre-determined categories such as 'health and fitness' and 'medical', and it is the apps that are thus categorised to which we refer here.) Over 100,000 medical and health apps for mobile digital devices have now been listed in the Apple App Store and Google Play (Jahns, 2014).

Given the newness of the many digital health technologies that

have recently emerged, including medical and health-related apps, little is known about how people are using these apps, whether the apparent benefits they promise are met and what their unintended consequences may be (Krieger, 2013; Lupton, 2014e, 2015b). However some research suggests that they are becoming used by increasing numbers of lay people. One survey of adult smartphone users in the United States found that the average number of hours respondents spent per month on using apps exceeded 30 h, and that the respondents used an average of 26 apps each (Nielsen, 2014a). Other American research has found that one fifth of smartphone users have used their phone to download a medical or health-related app. The most popular of these apps were related to monitoring exercise, diet and weight (Fox and Duggan, 2012). A recent market research study found that almost one-third of American smartphone users (equivalent to 46 million people) had used apps from the health and fitness category in January 2014 (Nielsen, 2014b). Many medical practitioners and other healthcare workers are also beginning to use apps as part of their professional practice (Buijink et al., 2013).

Despite the prevalence and apparent popularity of medical and health apps, very little critical sociocultural analysis has been

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undertaken to investigate the ways in which app developers present their wares and to site apps within the broader landscape of digital health technologies. Studies of health and medical apps have predominantly appeared in the medical and public health literature, and have taken an instrumental approach, directed at such issues as their effectiveness for behaviour change, the medical accuracy of the content or legal and regulation issues. Yet from a sociological perspective, digital devices such as health and medical apps have significant implications for the ways in which the human body is understood, visualised and treated by medical practitioners and lay people alike, for the doctor–patient relationship and the practice of medicine (Jutel and Lupton, 2015; Krieger, 2013; Lupton, 2014e, 2015b).

The research reported in this article analyses apps that have been formulated for the purposes of self-diagnosis of medical conditions by lay people. Our study engages in a critical content analysis of these apps, seeking to provide a perspective that incorporates the sociology of diagnosis with a focus on the role played by digital technologies: that is, addressing the topic of digitised diagnosis. As such, the study fits the perspective adopted by one of us as part of a critical digital health studies that seeks to challenge a techno-utopian and solutionist approach to digital health (Lupton, 2014d, 2014b). We sought to examine the ways in which self-diagnosis apps were portrayed on the Apple App Store and Google Play websites; specifically how the developers sought to frame the apps as useful, important and authoritative to attract downloads, and the implications of the apps' content for medical authority, personal data, the doctor–patient relationship and power relations in the act of diagnosis.

1.1. Digitised diagnosis

The sociology of diagnosis is concerned with diagnosis both as a process and as a category (Blaxter, 1978). It explores how these are socially framed, and in turn, frame the experience of health, illness, disease and medical care. A growing body of work has begun to focus on how diagnosis provides an important focal point for understanding the social and political elements of biomedicine. It offers a point of convergence and contestation for lay people and professionals; clinicians, administrators and politicians; corporations and scientists; and many others (Brown, 1990; Jutel, 2009, 2011; Jutel and Nettleton, 2011). Scholars addressing the sociology of diagnosis have contended that possessing the authority and legitimacy to make a diagnosis – to give a label to a collection of bodily signs and symptoms and thence to assert how illness and disease should be treated – is a source of power. This authority is a significant contributor to the status and dominance of the medical profession. The work of diagnosis legitimises the patient's complaint, organises the symptoms and gives sense to them, provides access to the sick role and distributes resources such as sick leave, benefits and therapies. It defines the lay–medical professional relationship, identifying the roles of the seeker and grantor of diagnosis, and creates sub-specialities with particular diagnosticians responsible for specific diagnostic categories (Jutel, 2011).

In recent times, however, diagnosis as process and the authority of the medical profession to effect diagnoses have been confronted by changes in the practice of medicine and the doctor–patient relationship. The patient role in interpreting symptoms has entered a phase of liberalisation. Beginning with the emergence of the consumerist movement in healthcare emerging in the 1970s, patients have been encouraged to be 'empowered' and 'engaged' in their care, to view the medical encounter as a 'partnership' and to participate in self-management practices rather than passively accept medical advice (Andreassen and Trondsen, 2010; Bury and Taylor, 2008; Lupton, 1997b, 2013; Nettleton and Burrows, 2003).

Patient empowerment and engagement are related concepts and are often used interchangeably. Both terms tend to refer to lay people taking control over their healthcare and personal health promotion, behaving as self-responsible, knowledgeable actors who are able to make informed, autonomous decisions and position themselves as 'partners' with their healthcare professionals (Fox, Ward, and O'Rourke, 2005; Lupton, 1997a, 2013). The movement of medical information online has been viewed as contributing to patient empowerment and engagement (Nettleton and Burrows, 2003). The notion of the 'digitally engaged patient' brings digital technologies into these discourses of engagement and active participation on the part of lay people by championing the use of these technologies as part of learning more about one's health (Lupton, 2013).

This liberalisation of the patient role has changed the diagnostic process. A vast array of medical information is now available on websites and platforms, including patient support platforms and social media sites in which lay people are able to exchange their experiences of diagnosis and medical treatment (Kivits, 2013; Lupton, 2014a; Murthy, 2013). Given the panoply of online sources of information about illness and disease, the contemporary patient has much greater access to opportunities to self-diagnose. While the patient has always contributed to diagnosis – by instigating the medical consultation, presenting symptoms for consideration, and even negotiating the diagnosis offered by the doctor (Balint, 1964) – today a patient, with the help of technology, might seek out the doctor not for the purposes of deciding the diagnosis, but rather for endorsing a diagnosis she or he brings to the consultation.

Contemporary diagnostic technologies include a growing array of self-diagnosis devices designed for the use of lay people. Home testing kits for such conditions as pregnancy and blood glucose levels and devices such as thermometers and blood pressure monitors pre-date the digital era. However new digital media and devices expand the range of technologies that are available to lay people to access information about illness and disease and perform self-diagnosis. There has been a trend towards self-diagnosis on the part of patients armed with the information they have been able to access online and the growing number of digital self-diagnosis instruments and direct-to-consumer kits that are now available on the internet (Goyder et al., 2010; Hynes, 2013). Such tools appear to be quite commonly used: one study (Fox and Duggan, 2013) found that one in three of the American adults surveyed had reported using online resources to self-diagnose or diagnose another individual.

The app offers one of the most recent digital tools by which self-diagnosis can take place. The mobility, ease of access and use of apps is a particular feature that differentiates them from earlier forms of digital diagnosis. Due to their simple format and location on mobile wireless devices, apps can be easily downloaded and carried around for constant reference or for updating information about, or comments from, the user and sharing these with others. A further important difference is the issues they raise for the security and privacy of the often very personal information that some of these apps generate about their users that are subsequently uploaded to the developers' archives and become their property. The data generated by apps and other software are now increasingly endowed with economic value, contributing to the 'big data' knowledge economy (Kitchin, 2014; Lesk, 2013). When people accept the terms and conditions of the developers when they install the app on their device, they typically are asked to give up their geolocation, unique phone identifier and details of their contact list even before they start using the app (McAllister, 2014). Once personal details are entered into an app, even more information is collected to which the developers have access. Many developers

sell these data to third parties for profit (Dredge, 2013).

App and platform developers have not always taken appropriate steps to safe-guard the often very personal details that are collected, including data on sexual practices and partners and reproductive functions that are collected by some apps (Lupton, 2015b). Several reports recently published by privacy organisations have noted the lack of details offered by many medical and health app developers of what they do with users' personal data. These reports state that many developers failed to properly inform users how their personal data were being used or made excessive demands for personal data from users (see, for example, Ackerman, 2013).

No previous sociological research has been directed at exploring the place of such apps in the diagnostic process or about their role in changing the social dynamic around, as well the nature of, diagnosis. This is a lacuna that our analysis of self-diagnosis apps sought to address. Our analysis takes the approach that health and medical apps may be conceptualised as the products of the interplay between the human actors who make decisions about their form, content and use and the affordances offered by digital technologies which delimit the scope within which apps can be developed and used. They should be considered sociocultural artefacts that assume certain kinds of capacities, desires and embodiments and also construct and configure them. Importantly, apps can have material effects, with the possibility of changing human behaviours and bodies. Apps may further serve political purposes by championing or supporting vested interests and established forms of dominance and authority. They are therefore participants in networks of meaning and power relations (Jutel and Lupton, 2015; Lupton, 2014e, 2014c).

2. Methods

The findings here reported draw from our larger study of medical diagnosis mobile apps directed at both health professionals and lay people. To identify relevant apps we undertook a search using the terms 'medical diagnosis' and 'symptom checker', that were available for download to smartphones in mid-April 2014 in the Apple App Store and Google Play. The descriptions of the apps that were listed under these terms were reviewed to determine whether they were directed at lay people for self-diagnosis or at medical professionals or medical students for use for differential diagnosis of patients or for education on carrying out diagnoses on patients. Only those apps that were in the English language were included. The apps that were assessed to be directed at a lay audience were singled out for separate analysis. Our analysis of the diagnosis apps for medical practitioners is described elsewhere (Jutel and Lupton, 2015).

A total of 35 apps claimed to assist lay people to engage in self-diagnosis for a range of conditions. Many more apps were directed at diagnosing specific illnesses or diseases, but they were excluded from the analysis because for our purposes here we wanted to focus on more comprehensive self-diagnosis apps that offered a diagnosis for a wide variety of conditions. The apps we examined typically adopt the approach of listing symptoms, asking a series of set questions based on the user's experiences of the symptoms and then producing a diagnosis based on the user's answers. Some then lead the user onto further information, including providing details of healthcare services.

Sixteen of the 35 self-diagnosis apps were available only in Google Play and 12 were offered only in the Apple App Store, while seven were offered in both stores. Details are provided in Table 1, including the name of each app, where it was offered, its price and number of times it had been downloaded where this was available (Google Play provides this information, but the Apple App Store

does not).

Like other media representations of health and medicine, including other digital forms such as websites and platforms (Kivits, 2013; Seale, 2005), apps are communicative agents that employ carefully chosen images and discourses to represent their use and function. Examining the words used in the app titles and descriptions on the stores and the images used, including the logo and screenshots employed to illustrate what the app offers potential users, is a way of identifying the tacit assumptions that underpin them and their truth and authority claims. A critical content analysis of apps is directed at identifying these communicative aspects (Lupton, 2014e). In adopting this approach, we reviewed each of the apps for its content and iteratively identified common themes or assumptions across the apps. We investigated the discursive and visual features of the description and screenshots provided for each app as it was presented in the app store websites. To accomplish this, for each app we reviewed the title, logo, app description text and screenshots provided. Where hyperlinks to the developer's website, terms and conditions and the privacy policy were provided, we clicked through to review these features, looking at how the developer described the intention of the app, where the content was derived from and how users' data were dealt with and used by the developers.

For all material examined we sought to identify the ways in which the categories of lay people and medical professionals and the authority to diagnose were portrayed. Following agreement about how the apps should be analysed, both authors conducted separate reviews and conferred about their findings. Any disagreements concerning interpretation of the apps content were reconciled by discussion between the authors. While such a content analysis cannot document how and why people may be using these apps, like analyses of other forms of media it can contribute insights into various aspects of the nature of apps, including the tacit assumptions and discourses on which they draw, trends and fashions in what kinds of medical and health conditions or problems are considered important to offer solutions, the portrayal of healthcare practitioners, patients and lay people or information about and the ways in which certain kinds of medical and health information are configured and reproduced (Lupton, 2014e, 2014c).

3. Findings

Several of the self-diagnosis apps we examined appear to be popular. It is evident from the download figures provided for the Google Play apps that some have been downloaded by tens or hundreds of thousands, and in the case of WebMD and iTriage Health, millions of smartphone owners. The WebMD and iTriage apps also featured on the Apple App Store's list of popular health and fitness apps at the time of the study. While we cannot know whether these apps are in fact used following downloading, this information does suggest a high level of interest from the app-using public.

The app developers used various claims to entice users. Their app descriptions assert that they will save lay people's time and money (by potentially allowing them to avoid a visit to the doctor), allay their anxieties, improve their health by allowing them to diagnose a medical condition and then seek treatment, educate them by enhancing their medical knowledge and support patient empowerment by bestowing information about diagnoses. For instance the developers of the Best Android Symptom Checker represent the app as 'a symptom checker which helps you answer the question: "Do I need to see the doctor?". If you have any medical worries or symptoms she [the 'Virtual Nurse' avatar] will put your mind to rest and could save you an unnecessary visit to a physician. It's like having a physician in your pocket!'

Table 1
Self-diagnosis smartphone apps available in the Apple App Store and Google Play, April 2014.

Google Play	Apple App Store	Both
<i>WebMD</i> Free, downloaded 5,000,000–10,000,000 times	<i>SymptomMD</i> \$AU4.99	<i>Isabel Symptom Checker</i> Free, downloaded 1000–5000 times on Google Play
<i>Best Android Symptom Checker</i> Free, downloaded 100,000–500,000 times	<i>Dignity Health</i> Free	<i>iTriage Health</i> Free, downloaded 1,000,000–5,000,000 times on Google Play
<i>Symptom Check by Symptomate</i> Free, downloaded 10,000–50,000 times	<i>CheckMySymptoms</i> Free	<i>Lenus</i> Free, downloaded 1000–5000 times on Google Play
<i>MyClinic Symptom Checker</i> AU\$2.99, downloaded 1000–5000 times	<i>iSymptom</i> \$AU6.49	<i>Your Rapid Diagnosis</i> \$AU5.49, downloaded 500–1000 times on Google Play
<i>Doctor Diagnose Symptoms Check</i> Free, downloaded 10,000–50,000 times	<i>Diagnoscope</i> \$AU2.49	<i>Your Diagnosis</i> Free, downloaded 1000–5000 times on Google Play
<i>Symptify – Symptoms Simplified</i> Free, downloaded 1000–5000 times	<i>Virtual Doctor</i> \$AU24.99	<i>Pocket Doctor Lite</i> Free (\$AU1.29 for the 'Pro' version with more features), downloaded 50,000–100,000 times on Google Play
<i>Medical Handbook</i> Free, downloaded 100,000–500,000 times	<i>Medical Symptoms</i> \$AU3.79	<i>Healthpedia</i> Free, downloaded 10,000–50,000 times on Google Play
<i>The Common Symptom Guide</i> Free, downloaded 100,000–500,000 times	<i>Symptoms Checker</i> \$AU6.49	
<i>MediCare</i> Free, downloaded 5000–10,000 times	<i>The Merck Manual Home Symptom Guide</i> \$AU6.49	
<i>Dr Moms Treatment Guide</i> Free, downloaded 10,000–50,000 times	<i>Child Symptom Checker</i> \$3.79	
<i>Doctor Online</i> Free, downloaded 10,000–50,000 times	<i>Adult Symptom Checker</i> \$AU3.79	
<i>Common Illnesses & Diagnosis</i> Free, downloaded 5000–10,000 times	<i>Medibank Symptom Checker</i> Free	
<i>Quick Care</i> Free, no download figures provided		
<i>Doctor Android MD Diagnosis</i> AU\$1.06, no download figures provided		
<i>Check My Symptoms</i> Free, downloaded 10–50 times		
<i>Diseases and Symptoms</i> Free, downloaded 10,000–50,000 times		

The rhetoric and imagery employed in apps are a major element used by developers to attract potential users' attention and establish authority. It was notable that the titles of many of the apps alone represent them as possessing medical authority and credibility. While the terms 'symptom' and 'diagnosis' were most common in app titles, the titles of several apps suggest that they act as proxies for physicians ('Doctor Diagnose', 'WebMD', 'Doctor Online', 'Virtual Doctor', 'Dr Android MD Diagnosis' and 'Pocket Doctor'). Words such as 'medical', 'clinic' and 'triage' in app titles and medical symbols such as stethoscopes and red crosses and images of doctors or nurses in logos and artwork were commonly employed to further establish authority and credibility. The image provided for Doctor Diagnose Symptom Check, for example, features a cartoon-like drawing of a man with grey hair, wearing a white medical coat and a stethoscope around his neck, both potent and well-recognised symbols of the medical profession. Medicare's logo uses a stylised male head and shoulders, with a white coat and tie and with a red cross emblazoned on the coat. Screen-shot images of the app's content use male and female avatars showed standing in a hospital room, with the male represented as an archetypal doctor dressed in a white coat and tie, and the female more ambiguously wearing blue scrubs (possibly a nurse or a doctor). Several apps also use full-colour anatomical drawings in the style of medical textbooks as part of the information provided on medical conditions.

Not only were medical symbols and terms used as a major claim for legitimacy of the information provided, but so too were those of computer science and data science. Technical computer terms such as 'algorithms', 'sensors', 'software engineers', 'deductive logic' and 'artificial intelligence' were often employed in the app descriptions to denote the aura of scientific objectivity and accuracy that supposedly can be established by computer software. This language

was used to lend an additional layer of authority to that already maintained by medicine over the diagnostic domain. The Symptify app description, for example, claims: 'Created by top doctors and software engineers, Symptify is an online self-assessment tool that uses a patent-pending, algorithmic engine to help users educate themselves about the causes of their symptoms.' Your Diagnosis also makes claims to authority based on 'medical algorithms' and 'a complex analysis of all information gathered about your symptoms and will produce a list of all possible and probable medical diagnoses'. Isabel Symptom Checker sells itself by claiming that it was an online tool originally developed for medical professionals but now 'for the first time' offered to lay people as an app. On the developer's website it is noted that: 'Using the latest searching technologies, the system can take a pattern of symptoms in everyday language and instantly compute from our vast database of 6000 diseases.'

For the majority of apps we examined the discursive features that used reference to medical expertise was often not accompanied by details that were able to provide support for this expertise. Previous studies of medical apps have found that many do not nominate specific medical experts in contributing to the content, or are vague in their attribution of authorship, using such terms as 'doctors' or 'a medical team' (Hamilton and Brady, 2012; Rosser and Eccleston, 2011). Similar findings were evident in our study. It was difficult to ascertain from reading the app descriptions how accurate and authoritative was the information provided on the apps. Many apps made no statements at all about from where the information was sourced and provided no hyperlinks to the developer's website. Others gave only vague details. For example, both the app description and the developer's website for Best Android Symptom Checker make mention of the app content being

contributed by the prestigious Harvard Medical School, but no further details are supplied to support this claim.

Sometimes clicking through to the developer's website does provide further information. No details are given about the credentials of information on the Your Diagnosis app description, for example, but the developer's website lists the names of Australian doctors who have contributed to the content. An examination of the other apps or online tools offered by the developers demonstrates a lack of persuasive medical focus or credentials. The developer of the Symptoms Checker app, for example, offers apps such as Mortgage Calculator, Shift Reminder and various games. Medical Symptom's developer has also produced Health Tips 1000, Buddha Quotes and Sex Secrets 1000, among others. The Common Illnesses & Diagnosis app is produced by a developer that has a range of other apps covering many topics, including some health-related apps but also apps focussing on logic puzzles, scary stories for kids and the history of Ancient Rome. This kind of developer offers little in the way of persuasive medical credentials.

Many of the apps employed the discourse of the engaged patient directly as part of their sales pitch. There were frequent references to these apps helping lay people to access medical information, assess their own symptoms and make decisions about whether or not to seek medical help. For instance the description for WebMD notes that it 'helps you with your decision-making and health improvement efforts'. It is claimed that the symptom checker part of the app allows users to '[s]elect the part of the body that is troubling you, choose your symptoms, & learn about potential conditions or issues'. The Rapid Diagnosis app description asserts that: '[t]he primary objective of this software is to encourage an active interest in health related problems, their diagnosis and treatment, and to empower patients by providing them with accurate, up to date knowledge, so that they may understand and participate in their health care.' The Dr Moms – Treatment Guide app is explicit in its positioning of mothers as acting in an authoritative medical role for their family members, describing it as: '[a]n app dedicated to all you Doctor Moms out there who function as the "doctor of the family" whenever anybody gets sick.'

Despite such appeals to lay people to download the app in the pursuit of 'taking control' of their health, most of the apps also prevaricate in other parts of the app description or on the developer's website or terms of use page. Even while focused on self-diagnosis and clearly directed at lay users the wording in many of these apps expressed caution about suggesting that a lay person should use them as the only method of diagnosis. For example they prefaced the use of the word diagnosis in the app descriptions with adjectives such as 'possible', 'probable' and 'likely' in relation to the diagnoses to which these apps might lead.

Frequently direct warnings are made for users not to act on the information they access on the app and to seek medical help instead, often including a refutation that the app is indeed directed at self-diagnosis. The Symptify app description is vehement on this point: 'Symptify.com does not provide medical advice and it is NOT intended for medical diagnostic purposes' (emphasis in the original). It is commonly claimed that the apps are directed at developing lay people's awareness or assist them in better seeking healthcare rather than replacing a doctor's expertise. For instance it is noted on the app description for Doctor Diagnose Symptoms Check that: 'This application doesn't intend to replace a doctor but rather to inform the patients and make them more aware.' Several apps are tagged with the caution that they are for 'entertainment purposes only'.

Several of the apps that we examined were used for promotional purposes that were not always readily apparent at first sight. Some apps, such as the Best Android Symptom Checker, provide contacts to actual physicians should users decide that their symptoms

warrant further investigation. In this app, a list of doctors is provided for real-time contact, paid for by the minute. As such, the app acts as a conduit for promoting doctors' services in ways that are not readily apparent from first appraisal of the app's content and purpose. The Symptom Check by Symptomate invites users to fill in personal details such as their gender, age, height and weight. They are then offered a 'free online checkup report', which may include agreeing to receive a newsletter. Further investigation of the developer's website's terms and conditions page reveals that the app may lead to referral to one of the doctors listed by the app, advice to buy a health insurance policy or use an online pharmacy that is partnered with the company, and that 'Symptomate may receive financial compensation for such referrals and affiliate programs'.

As we noted earlier, many app developers collect personal information about users. Our analysis of the self-diagnosis apps found that information about users' data privacy was provided by only a minority of the app developers. The WebMD website notably provides a detailed privacy policy for users, outlining how their personal information may be used when they register on the website or apps (including the Symptom Checker app). It does advise that users' personal information may be shared with third parties such as vendors, advertisers or suppliers who provide products or services to the company and to provide users with 'more relevant content and advertisements'. The Privacy Policy for the Best Android Symptom Checker is brief, but notes that they do not share users' personal information with anyone else and that the data that they collect on users are used to develop and improve the product and the user experience. Location data and usage data are collected.

The terms of use of Symptom Check by Symptomate also assign to the developer the right to use the personal data uploaded by users for any purpose. The privacy policy notes that users must agree to the developer transferring their data to third parties with or without the users' consent, including physicians, insurers, pharmacies and other third party health-related businesses. The Privacy Policy for iTriage Health outlines that personal data may be used for marketing purposes (including direct marketing to users by advertisers) and that this may include geolocation details that may be provided to their marketing partners together with other information so that 'personalized content' may be delivered and the effectiveness of advertising campaigns assessed. Personal data about the user and their use habits, therefore, are used to deliver targeted advertising.

4. Discussion

The very existence of self-diagnosis apps speaks to several important dimensions of contemporary patienthood and healthcare in the context of a rapidly developing ecosystem of digital health technologies. Self-diagnosis apps, like other technologies designed to give lay people the opportunity to monitor their bodies and their health states and engage with the discourses of healthism and control that pervade contemporary medicine (Crawford, 2006; Lupton, 2012, 2014e). They also participate in the quest for patient 'engagement' and 'empowerment' that is a hallmark of digital health rhetoric (Lupton, 2013). As the app description for Symptom Checker by Symptomate puts it, such apps are directed at those who are motivated to 'take care of your health'. Such technologies represent the vagaries of human embodiment as amenable to control if sufficient vigilance and self-responsibility are exercised on the part of lay people. The judicious gathering and use of information, including that provided on online forums and medical and health-related apps such as those examined here, is represented as the key to managing illness and disease.

The novel ways in which the digitisation of medical information is occurring are also dominant features of self-diagnosis apps. Many

forms of digitised bodies can now be viewed using digital technologies, from YouTube videos of childbirth, surgical procedures, pro-anorexia, self-harming, body-building and fat activist websites to Facebook pages and blogs written about their illnesses by patients (Lupton, 2015a). Self-diagnosis apps are one such mode of digitised embodiment, which often rely on new digitised calculation technologies, as represented by the algorithms, large databases, artificial intelligence and so on that feature in apps' descriptions. As scholars writing about digital data practices have emphasised, the technical affordances of such software tends to represent computer codes and software as authoritative because they are positioned as independent of the frailties of human-decision making. Algorithms have played an increasingly dominant role in making decisions about people, predicting their behaviours and formulating solutions to problems. They offer a new form of logic (Totaro and Ninno, 2014), and a new form of expertise and power: that of 'algorithmic authority' (Cheney-Lippold, 2011).

In the context of self-diagnosis apps, these forms of calculation are portrayed as offering certainty and objectivity to the practice of self-diagnosis as part of participating as a digitally engaged patient. They overtly are positioned as neutral, objective technologies for effecting a diagnosis that differ from the traditional hands-on approach upon which medical practitioners rely. As we have found, however, the algorithmic authority offer by self-diagnosis apps and their appeals to healthism and patient empowerment are undermined by their disclaimers. Self-diagnosis apps inhabit an uneasy space between the engaged patient and the expert medical professional. While many of the apps seek to position lay people as empowered or engaged consumers of health information and healthcare, most shy away from suggesting that this empowerment go too far by challenging medical authority. Potential users of these apps are cautioned to use the information they derive from the apps judiciously by seeking further medical advice from the 'real' experts: qualified doctors.

While the cautions that are offered on the apps that they are for 'entertainment purposes only' and not designed to 'replace a diagnosis from a medical professional' may be added for legal reasons, they detract from the authority that the app may offer and indeed call into question why anyone should use it. In any diagnostic process, the lay person must initially engage in pre-diagnosis work before seeking medical attention (Balint, 1964; Jutel, 2011). However the apps amplify the role of the lay person in this process. The symptom check list shapes the presentation of dysfunction and changes the locus of authority (Ebeling, 2011). The app cannot be considered merely a simple tool for organising symptoms because of the pivotal ways in which discerning and interpreting symptoms shape diagnosis in general.

There also remains the issue of how healthcare practitioners may respond to patients who have attempted self-diagnosis using apps like these. For consumer and patient support groups, the ideal of the empowered patient is a means by which medical dominance may be challenged. For governments, this ideal is viewed as key to reducing healthcare costs in an age of austerity (De Vogli, 2011; Mort et al., 2013). Writers contributing to the medical literature demonstrate ambivalence, with some supporting the concepts of patient engagement and participatory medicine, but others articulating unease about the extent to which patients should 'take control' over their healthcare (Lupton, 2013; Prainsack, 2014). With respect specifically to diagnosis, the medical profession has been reluctant to surrender its professional authority to the lay person. While early recognition of symptoms is integral to many health promotion initiatives, with the exception of influenza (see Jutel and Bannister, 2013), we are unaware of any diagnoses where the diagnostic authority of the lay person is accepted formally by medical or public health organisations. A review of the medical

literature on self-diagnosis highlighted that medical writers have argued for its utility in cases where early disease recognition is paramount for individual or public health protection, or where medical resources are scant (Jutel, 2010).

Lay people may struggle to know how to deal with the information they access from self-diagnosis apps. Users are placed in a position that many may find difficult: of evaluating the claims to authority and legitimacy of the content of each app and its developer. As we found in our research, determining how the content is created, who performs this content creation, how often it is updated, the commercial sponsors of the developers and the uses to which any personal data that are uploaded to the developers' data archives are put can involve thorough investigation, including time spent in following hyperlink trails. In many cases, such information is simply not provided.

The commercial interests underpinning self-diagnosis and other medical and health apps require further investigation. Many stakeholders now compete for lay people's attention in the world of digital health information, including members of the medical profession and allied health professionals, health insurance companies, pharmaceutical and medical technology companies, hospitals, patient support associations, government agencies and digital device and software developers (Lupton, 2014a; Rozenkranz et al., 2013). However it is not always apparent where vested interests lie in the provision of medical information in digital formats either for lay people or members of the medical profession (Ebeling, 2011; Jutel and Lupton, 2015; Lupton, 2014a; Read, 2008).

Technologies designed for self-diagnosis are part of a lucrative commercial market, promoted in the interests of the manufacturers who sell these technologies or pharmaceutical companies whose products are recommended by the devices (Childerhose and MacDonald, 2013; Ebeling, 2011; Prainsack, 2014). Self-diagnosis apps are also part of a growing market aimed at promoting the digitally engaged patient. The emergence of self-diagnosis has been enabled by both technology and consumerism or, not unlike what Clarke et al. (2003, 167) refer to as 'Biomedical TechnoService Complex, Inc,' the "corporatized and privatized (rather than state-funded) research, products and services made possible by technoscientific innovations that further biomedicalization'. At present there is no way of fully identifying the role that pharmaceutical companies or medical device developers may have played in contributing to the content of apps. Yet it is known that such companies are increasingly developing and distributing apps as part of their marketing efforts, raising issues of conflict of interest (Buijink et al., 2013; Ebeling, 2011).

One important difference between diagnosis apps and previous diagnostic technologies is the potential they hold for contravening the privacy of users. The value of big digital datasets for health and medical-related purposes is becoming increasingly recognised (Lupton, 2014a; Neff, 2013). In this context of the increasing collection, storage and monetisation of digital data, data security is a pressing concern for users of health and medical apps (McCarthy, 2013). For those apps which are designed for online use, in many cases users cannot be sure of how their data will be archived or on-sold to third parties because no details are given. Indeed in countries such as the United States, there are no legal requirements that app developers provide privacy policy statements on their information materials for users. A recent study of privacy policies on mobile health and fitness-related apps found that many lacked any kind of privacy policy, few took steps to encrypt the data they collect and many sent the data collected to a third party not disclosed by the developer on its website (Ackerman, 2013).

As our research demonstrated, the developers of medically-related apps, platforms and websites frequently sell the data that users contribute to third parties for commercial use (see also

Lupton, 2014a). Furthermore, even though the majority of the apps we examined can be downloaded for free, they are often imbricated in a broader commodity culture by the app developers, several of whom are associated with private or public healthcare providers and health insurers. The commercial interests of app developers are not necessarily provided on the app description or the developer's website and thus may remain hidden to scrutiny. The different agendas that may lie behind these apps, therefore, are largely hidden from users' sight.

5. Conclusion

In this article we have adopted a perspective in our analysis of self-diagnosis apps that represent them as having potential socio-cultural and material significance and effects. Our analysis of self-diagnosis apps suggests that they inhabit a contested and ambiguous site of meaning and practice. As sociologists of diagnosis emphasise, regardless of who undertakes the process of diagnosis, it is always contingent, an attempt to impose order upon a collection of bodily signs and symptoms. When medical practitioners undertake diagnosis their authority as doctors tends to obscure the contingency of their decision-making. When lay people undertake self-diagnosis using apps, by contrast, while the apps may promise a compelling combination of medical expertise and the algorithmic authority offered by their software, the uncertainty of their decision-making tends to be highlighted by virtue of their status as 'not medically qualified'. We would contend that despite the existence of devices such as self-diagnosis apps and other forms of digitised diagnosis, the diagnostic process is technically, administratively and legally still the preserve of medicine. This protected sphere is reproduced regularly by all the participants in the diagnostic process, including many of the self-diagnosis apps we examined. The app-generated diagnosis does not offer access to prescriptions, laboratory tests, sick leave or myriad other resources for which the doctor remains the gate-keeper even if diagnosis is the key.

Many questions have been raised by our study. While it is evident from download figures provided by Google Play that some self-diagnosis apps have been downloaded by tens of thousands or even millions of people, we do not know how the apps are used and how these diagnoses affect the doctor–patient encounter. What are lay users to make of the competing discourses of empowerment and acquiring medical knowledge and the insistence of the continuing authority of the medical profession to effect a 'proper' (expert) diagnosis that pervade many of these apps? What do they do with the diagnosis they extract from the app? How valid should they assume the diagnosis is? Do they seek further advice from medical professionals once a digitised diagnosis has been effected? How can lay people determine what commercial interests lie behind the apps' development and how their (often very personal) data may be used? How are medical practitioners responding to self-diagnoses effected by lay people and how do they negotiate these diagnoses with their patients? How are people in different geographical areas, with variable access to healthcare and of differing levels of education using these apps? All of these questions remain to be answered and require further critical sociological investigation.

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