Circles and Analogies in Public Health Reasoning

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Abstract

The study of the fallacies has changed almost beyond recognition since Charles Hamblin called for a radical reappraisal of this area of logical inquiry in his 1970 book Fallacies. The "witless examples of his forbears" to which Hamblin referred have largely been replaced by more authentic cases of the fallacies in actual use. It is now not unusual for fallacy and argumentation theorists to draw on actual sources for examples of how the fallacies are used in our everyday reasoning. However, an aspect of this move towards greater authenticity in the study of the fallacies, an aspect which has been almost universally neglected, is the attempt to subject the fallacies to empirical testing of the type which is more commonly associated with psychological experiments on reasoning. This paper addresses this omission in research on the fallacies by examining how subjects use two fallacies – circular argument and analogical argument – during a reasoning task in which subjects are required to consider a number of public health scenarios. Results are discussed in relation to a view of the fallacies as cognitive heuristics that facilitate reasoning in a context of uncertainty.

Keywords: analogical argument, circular argument, heuristic, informal fallacy, public health, reasoning, uncertainty

I. Introduction

The study of the fallacies has changed considerably in the forty years since Charles Hamblin railed against the shortcomings of the so-called Standard Treatment of these arguments in logic textbooks. Thus Hamblin (1970, p. 12) writes:

> *And what we find in most cases, I think it should be admitted, is as debased, worn-out and dogmatic a treatment as could be imagined – incredibly tradition-bound, yet lacking in logic and historical sense alike, and almost without connection to anything else in modern logic at all. This is the part of his book in which a writer throws away logic and keeps his reader's attention, if at all, only by retailing traditional puns, anecdotes, and witless examples of his forbears.*

Where philosophical reflection on the fallacies before Hamblin's powerful critique was based upon artificially constructed examples which bore little or no resemblance to the types of arguments that are found in everyday reasoning, the post-Hamblin era in fallacy analysis has witnessed an increase in research which places emphasis on the types of arguments that people actually employ. Examples of fallacious arguments are now much more likely to come from sources such as newspapers, magazines, and other media outlets than they are to originate in the misguided attempts of fallacy theorists to construct plausible (but artificial) arguments. To see that this is the case, one need only look at Walton (2008) where examples of

fallacious arguments from actual sources are in abundance. Examples include a discussion of ad hominem argument based on an article in the *National Post* (2005), appeals to authority using an article featured in *Newsweek* (2002) and the argument from popularity based on a televised interview with a politician during the Canadian Broadcasting Company programme *This Week in Parliament* (1987).

The move to more naturalistic data for examination by fallacy theorists has undoubtedly had benefits for the theoretical frameworks of the fallacies that have emerged. The increased authenticity of these frameworks is a direct consequence of efforts to engage with people's actual reasoning. One aspect of this improved authenticity is the development of new criteria for the evaluation of arguments. Arguments are now as likely to be characterised as fallacious if they violate discussion rules in a dialogue or conversation as they are if they fall short of some deductive standard of validity or soundness. This new emphasis on people's actual reasoning is part of a wider pragmatic turn in the study of fallacies, a turn in which aspects of context (a notion despised by earlier theorists) must be considered in any assessment of an argument. The arguer and his or her motivations for producing an argument is an integral part of context. The person who produces and receives arguments, it seems, has never before been so important to the study of the fallacies.

One example of this pragmatic turn is the pragma-dialectical framework of Frans van Eemeren and Rob Grootendorst (1984, 1995, 2004). This framework draws on speech act theory and other insights of Grice and Searle in developing an account of argumentation. Speech acts that violate one of the rules for a critical discussion and undermine attempts to resolve a difference of opinion are characterized as fallacies: "Any infringement of one or more of the rules, whichever party commits it and at whatever stage in the discussion, is a possible threat to the resolution of a difference of opinion and must therefore be regarded as an incorrect discussion move. In the pragma-dialectic approach, fallacies are analyzed as such incorrect discussion moves in which a discussion rule has been violated" (van Eemeren and Grootendorst 1995, p. 136). (For further discussion of pragma-dialectics, see Cummings (2010a).)

But appearances can be deceptive. Notwithstanding the emphasis on the role of the arguer in reasoning and on examining actual arguments as opposed to artificially constructed arguments, there is a very real sense in which fallacy theorists are still failing to engage with actual reasoners. Almost nothing is known about the cognitive and other psychological processes that people use to assess that group of fallacious arguments about which Hamblin had most to say, the informal fallacies. This should be compared to the extensive psychological literature that exists on deductive reasoning and fallacies and the equally large literature that exists on induction and errors of probabilistic reasoning. For example, a prominent psychologist of deduction, Philip Johnson-Laird, has proposed a mental models theory to account for people's performance (including fallacies) in deductive reasoning tasks (see Johnson-Laird and Byrne (1991) for extensive discussion). The work of Amos Tversky and Daniel Kahneman (1974) was most notable among the first investigators to study the types of errors subjects committed during probabilistic reasoning. (See Kahneman's 2011 engaging account of their research in *Thinking, Fast and Slow.)*

In contrast, no one has subjected the informal fallacies to experimental investigation, even though similar studies of other areas of logic have yielded useful results about the logical processes that people find rationally compelling. There are various reasons for this omission. Chief amongst them is an aversion to psychologism in logic. I concur with the stance on psychologism taken by Gabbay and Woods (to appear) in their empirically sensitive logic: "Investigators who make room for context and agency are

drawn to a form of what used to be called the Laws of Thought approach and, accordingly, are committed to an element of *psychologism in logic. . . . Psychologism is once again an open question in the research programme of logical theory. Its re-emergence should not be prejudged. Better to wait and see how, once it is up and running, a psychologically real, agent-based logic fares as a theory of reasoning"* (italics in original).

Indeed the very fact that other branches of logic have survived the approaches of psychology (and not just survived these approaches, but positively benefited from them) should reassure fallacy theorists that their particular corner of logic can only be enhanced by input from psychological studies of the informal fallacies. At least this is my starting point for the discussion in the current paper. The arguments investigated in this study – circular argument and analogical argument – have been extensively discussed in the fallacy and argumentation literature. But no one has previously attempted to elicit responses from subjects concerning the conditions under which these arguments are judged to be more or less warranted. This paper undertakes to do just that in the context of a task that examines public health reasoning.

The choice of public health reasoning as a context in which to examine circular and analogical arguments is motivated by the following considerations. The central claim of this paper is that many informal fallacies function as cognitive heuristics which can facilitate reasoning in contexts of uncertainty. The uncertainty in question may lie with scientists themselves, as when they are confronting an emerging infectious disease such as Severe Acute Respiratory Syndrome (SARS) or Bovine Spongiform Encephalopathy (BSE) and there is little or no knowledge of how the pathogens responsible for these diseases will behave. This lack of knowledge often extends beyond those scientists who are directly charged with responding to a public health problem to other medical professionals who provide advice on risk to the public. There is evidence that on the issue of BSE at least, medical professionals lacked sufficient knowledge to give advice to the public about the disease. Simpson et al. (1996) conducted a survey of knowledge of BSE among 1,038 doctors in North Yorkshire, England. These investigators found that most doctors (55%) thought that their knowledge of BSE was inadequate for them to give advice to the public.

Alternatively, it may be a member of the public who is experiencing uncertainty, as when a person is attempting to assess the significance of some public health issue but lacks the scientific knowledge that is required to undertake such an assessment. In both scenarios, a lack of knowledge can be successfully bridged through circular and analogical reasoning. To the extent that these reasoning strategies permit scientists and lay reasoners to move beyond gaps in their knowledge and make decisions about public health issues, these strategies can be seen to serve as cognitive heuristics that facilitate reasoning in contexts of uncertainty. The heuristic value of these strategies for scientists addressing the emergence of BSE and HIV/AIDS has been described in various publications to date (Cummings, 2002, 2004, 2009, 2010b, 2011, 2012a-c, 2013a-b, 2014a-e, 2015a-b). This is the first study to examine how these same strategies are employed by lay reasoners, who must also cope with uncertainty in dealing with public health problems, albeit uncertainty that is generated through a rather limited (in some cases, non-existent) knowledge of the scientific issues involved. It is expected that the lay reasoner will also find these reasoning strategies to be a facilitative cognitive resource in the face of uncertainty.

II. Arguments as Cognitive Heuristics

While the idea that certain fallacies can function as cognitive heuristics during reasoning about public health problems is

new, the place of heuristics in reasoning is actually well established. Reasoning heuristics were first systematically studied by Amos Tversky and Daniel Kahneman. In their landmark article "Judgment under Uncertainty: Heuristics and Biases," Tversky and Kahneman (1974, p. 1124) described a number of heuristics that reasoners use in probabilistic reasoning: "Many decisions are based on beliefs concerning the likelihood of uncertain events…people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations." Although Tversky and Kahneman acknowledged that heuristics could be useful, they were concerned to emphasise the "severe and systematic errors" to which heuristics could lead. For example, one such error is known as the gambler's fallacy, the belief that random processes self-correct: "if [a random] sequence has strayed from the population proportion, a corrective bias in the other direction is expected" (Tversky and Kahneman, 2004, p. 193). (For an extensive and up-to-date account of their research program see Kahneman, 2013.)

By the time heuristics began to receive sustained attention in the literature on risk, an altogether more benign view of these cognitive operations was beginning to take shape. The emphasis now was less on the errors in reasoning to which heuristics might lead and more on their facilitative function in dealing with complex problems. Some of these problems concerned issues of public health significance. Trumbo (2002) and Johnson (2005) discussed heuristics in two studies that applied a heuristic-systematic model to the assessment of risk. These studies required subjects to assess risks that were communicated in epidemiological information about cancer rates (Trumbo) and which were posed by a semi-hypothetical industrial facility (Johnson). Johnson (2005, p. 632) states that

> *"[a]…heuristic-systematic model (HSM) separate[s] systematic from heuristic information processing. The systematic approach…is deliberative, attends to detail, weighs alternative views, and assesses argument quality in judging the validity of persuasive messages. The heuristic approach is alert to cues (e.g., trusted groups' evaluation of the information) and simple decision rules (if encoded in memory, accessible to recall, and deemed reliable) justifying quick intuitive judgment."*

Wilson et al. (2004) examined heuristic processing in a study of how adults assessed risks associated with genetically modified food crops.

So heuristics are not a new phenomenon in the study of reasoning or even the study of public health reasoning. But what is novel about the approach adopted in this paper is that no-one has previously attempted to cast certain informal fallacies in terms of cognitive heuristics that people employ when they form judgements about public health problems. Yet, there is much to recommend this approach. For those philosophers and logicians who have subjected the informal fallacies to serious scrutiny, the rewards have been plentiful. Quite apart from being examples of weak, bad, or shoddy reasoning, the informal fallacies have been found to be rationally warranted arguments within certain contexts of use. A sizeable literature now exists on non-fallacious variants of most of the major fallacies. The work of two fallacy theorists – Douglas Walton and John Woods – has been particularly influential in this regard. In a large number of books and journal articles, these theorists have described non-fallacious forms of *petitio principii* (begging the question), *argumentum ad ignorantiam* (the argument from ignorance), and *argumentum ad baculum* (the argument from the stick or appeal to force), amongst others (Walton 1985, 1992; Woods 1995, 2004). Of course, in emphasizing that there exist non-fallacious variants of the fallacies, this is not the same as saying

that there are no such things as fallacies. For discussion of novel fallacious arguments in the context of the BSE problem, see Cummings (2005).

An altogether smaller literature has sought to describe how these fallacies function non-fallaciously within the context of important public health issues (Cummings, 2002, 2004, 2009, 2010b, 2011, 2012a-c, 2013a-b, 2014a-e, 2015a-b). What these latter studies have revealed is that these argument forms can sustain reasoning in contexts that preclude other modes of reasoning, principally deduction and induction. These contexts exhibit pervasive uncertainty of the type commonly encountered at the outset of a scientific inquiry or when deliberations exceed a reasoner's available cognitive resources. In the sections to follow, we examine the features of two such heuristics, circular argument and analogical argument. The findings of a study that examines the conditions under which reasoners accept and reject these argument forms are described. In reporting findings from a psychological study of the fallacies, this study goes beyond the exclusively philosophical literature that exists on the informal fallacies.

II.A Circular Argument

Circular argument, also variously known as *petitio principii*, question-begging argument and *circulus probandi*, has long been a source of fascination for philosophers and logicians. This argument is a strange hybrid of deductive validity and epistemic unacceptability. An argument of the form 'p, therefore p' is none other than the principle of identity in formal logic. Woods and Walton (1975, p. 107) describe how "[a]rguments of the form 'p, therefore p' always or nearly always beg the question, yet their formal validity is impeccably reflected in standard first-order logic." Perelman (1982, p. 22) states that "[t]he affirmation if p, then p, stating that a proposition implies itself, is not only true but is a fundamental logical law: it is the principle of identity."

However, a premise that is as unknown as the conclusion to be proved, which must be the case in any argument in which the premise and conclusion are one and the same proposition, cannot satisfy the epistemic requirement that the premise of an argument should be more certain than, or better known than, the conclusion to be proved. According to Biro (1984, p. 239), the problem with question-begging argument is that it is "epistemically non-serious," where epistemic seriousness describes an argument in which the premises are more knowable than the conclusion. It is the perceived failure of circular argument to develop the grounds for a thesis that has seen this particular argument form almost universally condemned by theorists. For Rescher (1977, p. 11), circular sequences in disputation must be blocked since they "frustrate the aim of the [dialectical] enterprise" which is "to deepen the grounding of the contentions at issue." If the only ground that can be advanced in support of a thesis is the thesis itself, it is argued, then we have not established or proven a response to the question-at-issue so much as merely "begged" for its acceptance. It seems that extensive philosophical preoccupation with circular or question-begging argument has produced few defenders of this argument form and even less to recommend it by way of rational merits.

As question-begging argument began to be submitted to a more systematic treatment in a post-Hamblin era of fallacy analysis, it soon became apparent to analysts that arguments with a distinctly circular form were not all inherently fallacious. Indeed, many such arguments were merely reflecting certain natural cyclical processes at work in fields such as economics, mathematics, geology, palaeontology and even epistemology (Walton, 1985; Cummings, 2000). For example, with regard economics, Walton (1985, p. 272) remarks that

"in the majority of circular arguments

> *we looked at, the circularity cannot be condemned as wrong or fallacious precisely because the context of dialogue fails to indicate decisively that a priority condition is a procedural requirement. The economist's argument we began with, for example, should not be declared fallacious or viciously circular by a reasonable critic unless the critic can cite evidence of an agreement, or at least a clearly agreed upon context or background requirement to argue only in one direction or the other…If the objective (the problem) is to prove from A to B, and also from B to A, there need be no fallacy in solving the problem by arguing in a circle."*

With regard to mathematical arguments, Walton (1985, p. 263) allows that

> *"[i]n mathematics, it is common practice to start at proposition A and then prove B, then start again at B and prove that A follows. An equivalence proof in mathematics, of the if and only if type, often takes this form. Although the form of proof is circular, in many instances such a proof is rightly thought non-fallacious."*

The decisive factor in an evaluation of question-begging argument is now less the structure of these arguments than the purpose(s) for which they were advanced. If that purpose included a requirement to argue from better known, or more established, propositions to less well known, or less established, propositions, then the circular structure of question-begging argument is clearly problematic. However, if there is no such requirement for evidential or epistemic priority in a particular context of argument, then an accusation of fallacy against the proponent of a circular argument is altogether less tenable. At the outset of scientific inquiry, particularly inquiry into a newly emerging infectious disease like BSE, there are few well-known, established theses at the disposal of investigators. To insist that scientists fulfil a priority requirement at this stage of scientific inquiry is to misrepresent the epistemic standing of the propositions that are available to scientists in this context. A more sensible epistemic policy is to suspend this priority requirement until such times as a knowledge base of well-established propositions is available to investigators. In the interim period, it is quite legitimate for scientists to use a proposition as a premise in argument that is no better established than the conclusion to be proved.

In Cummings (2010b), it is argued that circular argument was used non-fallaciously by scientists who sat on the Tyrrell Consultative Committee on Research during the BSE epidemic in the UK. The assumption of the question-at-issue in the deliberations of this committee permitted scientists to advance their investigations until such times as evidence that was independent of the conclusion to be proved could be obtained. Circular argument served as an effective and rationally warranted cognitive heuristic for scientific investigators in this context, a heuristic that enabled scientists to inch forward in inquiry at a time when little was known about BSE. Circular argument, it is argued, has a similar heuristic value for the lay reasoner who is attempting to assess the significance of public health problems in the absence of knowledge of the scientific issues involved. It is expected that lay reasoners will judge this argument to be rationally warranted under certain epistemic conditions and unwarranted under other conditions. Where this argument is seen to advance some type of inquiry – either a reasoner's personal cognitive inquiry into an issue or the more formal inquiry of scientists into a problem – in the absence of evidence or knowledge relating to a topic, then this argument may be assessed by reasoners as being rationally warranted or as possessing some epistemic virtue. By implication, if evidence which is independent

of the conclusion to be proved is available to the reasoner, but the reasoner neglects to use it in favour of the question-at-issue, then it might reasonably be expected that this type of reasoning would be unfavourably assessed and judged to be lacking in rational warrant. The study described below in Section III will establish the conditions under which subjects are inclined to identify circles in reasoning as virtuous and vicious, respectively.

II.B Analogical Argument

A second fallacy that has attracted condemnation and praise in roughly equal measure from philosophers and logicians is the argument from analogy. One such condemnatory voice was that of John Stuart Mill. Mill remarked as follows of analogy: "This very common aberration [overrating the probative force of analogy] is sometimes supposed to be particularly incident to persons distinguished for their imagination; but in reality it is the characteristic intellectual vice of those whose imaginations are barren…To such minds objects present themselves clothed in but few properties; and as, therefore, few analogies between one object and another occur to them, they almost invariably overrate the degree of importance of those few" (1978, p. 795).

Analogical argument has been extensively discussed within different theoretical perspectives and disciplines. The interested reader should see Guarini et al. (2009) for a comprehensive overview of these perspectives and disciplines. Klahr (2000, p. 26) states that "in the past twenty-five years, analogy has assumed a central role in theories of problem solving and scientific discovery and its underlying mechanisms have been studied in great detail." At its most basic, however, the argument consists in an analogical premise that expresses a similarity or likeness between two entities A and B, and a second premise states that A has property P. From these two premises the reasoner then derives the conclusion that B also has property P. As Brown (1989, p. 162) puts it: "Analogy is often explained as a special kind of comparison (or similarity) between two objects (events, ideas, classes of objects, etc.) such that the possession in common of one (or more) characteristic (property, attribute, etc.) by both objects is believed to imply that the two objects probably have some other characteristic(s) in common."

The following example of analogical argument is based on the reasoning of scientists in the UK during the BSE epidemic:

> Scrapie in sheep and BSE in cattle are similar in certain respects.
> Scrapie is not transmissible to humans.
> Therefore, BSE will not be transmissible to humans.

This particular analogical argument was established on the basis of the most tentative (largely epidemiological) evidence – only strain-typing studies could establish definitively if scrapie and BSE were related diseases and these studies were not available to scientists in 1986 when BSE first emerged in British cattle. The analogy established in the first premise of this argument was therefore at best weakly warranted (hence, the status of this argument as a weak analogy). Yet, as it was argued in Cummings (2010b), this particular argument served an important heuristic function for scientists who were confronted with the emergence of this new bovine disease. The analogy set in place a well-defined research agenda for scientists investigating BSE. Scrapie had been extensively studied by British scientists since the 1940s and all aspects of this disease – its genetic basis, histopathological features, transmission properties, etc. – were well documented and understood. By providing a template for how BSE might behave, the scrapie analogy set in place for scientists a number of specific

research questions that could be usefully pursued. This facilitated the inquiry process at a time when there was considerable public concern about the risks that BSE posed to human health and scientists were under pressure to address these risks. Under these circumstances, even weak analogical argument was preferable to a scenario in which inquiry could not be initiated owing to a lack of knowledge.

Analogical argument, it is argued, has an equally facilitative role to play in the reasoning of the general public. Like professional scientists, lay reasoners must overcome uncertainty and lack of knowledge during their deliberations on a whole range of issues, public health problems specifically included. Where the scientist must address a lack of knowledge that is imposed on an inquiry when a disease first emerges or when certain ethical or technical restrictions limit the investigations that can be undertaken, the lay reasoner must contend with a lack of knowledge that is imposed on his or her reasoning by certain cognitive limitations (e.g. limited understanding of the scientific issues involved in a particular public health problem). It is expected that under these conditions analogical argument will function as a productive resource, steering the reasoner in a direction that will most likely secure the attainment of his or her cognitive goals, which in this case is judgement about public health problems. The lay reasoner, it is hypothesised, will use analogical argument to arrive at judgements about issues that are beyond his or her cognitive grasp. The heuristic value of this particular reasoning strategy thus consists in its capacity to help the reasoner assimilate complex scientific information by establishing similarities with other, better understood phenomena. Glik (2007, p. 37) captures this same idea when she states "a new illness that fits an infectious disease prototype will be more easily understood or assimilated if a person already has a mental model of how an infectious disease is transmitted." So, contrary to John Stuart Mill and other detractors of analogical argument, it is then predicted that lay reasoners will be competent judges of the conditions under which such a reasoning strategy is more or less rationally warranted. Indeed, this is one of the empirical theses that will be explored in the study described in Section III.

III. An Experimental Study of Two Informal Fallacies

IIIA. Rationale

This study is an experimental investigation of the informal fallacies, a branch of inquiry that has been the exclusive domain to date of logic and philosophy. It is the first attempt to examine how the public reasons using these argument forms in a public health context. The aim of this study is to establish the conditions under which subjects judge circular and analogical arguments to be rationally warranted during deliberation on public health problems. These problems are characterized by a high degree of scientific knowledge which lay reasoners lack and which they are often unable to acquire on account of cognitive and educational limitations. Both argument forms are thus serving as cognitive heuristics that facilitate the public's reasoning about these problems in the absence of knowledge.

When one thinks of experimental investigations of reasoning, the work of cognitive psychologists such as Phillip Johnson-Laird on deductive reasoning typically comes to mind. While this study shares certain features with this work – the presentation of stimulus material that tests if certain inferences have been drawn by subjects – it also differs from this work in significant ways. For example, studies of deductive reasoning present information in the form of premises in a structured argument to subjects, who are then required to draw a conclusion or judge the validity of a presented conclusion. In the current study, reasoning is examined

in a discursive context with subjects asked to justify their assessment of the reasoning of certain scientific actors. To this extent, this present study is more akin to the experimental reasoning studies of David N. Perkins, who has studied how subjects reason about everyday issues which are often polemical in nature, e.g. whether or not a military draft in the United States would increase American influence in the world. (See Perkins (1989) and Perkins et al. (1983).) It is worth noting that Finocchiaro (1994, p. 14) has remarked of Perkins's approach that it is "much more valid than the usual experiments and provides the only effective experimental means of getting in touch and coming to grips with the phenomenon of reasoning."

It is hypothesized that subjects will judge circular argument to be most warranted under two conditions:

(1) when a problem is characterized by pervasive uncertainty and investigators have no option but to proceed from premises in reasoning that are identical to, or dependent on, the conclusion to be proved, and

(2) when the assumption of the conclusion to be proved helps investigators push forward in inquiry, i.e. when there is some perceived benefit for investigators of assuming the question-at-issue.

By implication, subjects will be less inclined to describe circular argument in positive evaluative terms if

(3) evidence relating to the question-at-issue is abundant but investigators choose to overlook this evidence in favour of conclusion-dependent evidence, or if

(4) subjects perceive that the assumption of the question-at-issue has not facilitated inquiry in that no progress has been made in terms of addressing a particular question or problem.

It is predicted that subjects will identify circles as *virtuous* (rationally warranted) under conditions (1) and (2), and as *vicious* (rationally unwarranted) under conditions (3) and (4).

There are four public health scenarios that were used to examine circular argument:

(a) an epidemiological investigation of fever in patients following vaccination for pneumonia,
(b) an investigation of a disease outbreak in the Congo by scientists from the World Health Organization,
(c) an investigation by environmental epidemiologists of a purported link between electromagnetic radiation and birth defects and
(d) the discovery of a bizarre disease by medical anthropologists who are working in a remote region of Peru.

The types of circular arguments investigated in the study are shown below:

1. Virtuous circle; positive outcome (public health scenario (a) above)
2. Virtuous circle; lack of evidence (public health scenario (b) above)
3. Vicious circle; negative outcome (public health scenario (c) above)
4. Vicious circle; abundant evidence (public health scenario (d) above)

It is also hypothesized that subjects will be competent judges of the conditions under which analogical arguments are more or less rationally warranted. Where an analogical premise is strongly warranted, for example, a similarity between two diseases such as HIV and hepatitis B is established through epidemiological investigation, it is expected that subjects will be inclined to accept a conclusion in which the property of one disease is believed also to hold of the other disease. In this case, the conclusion is that HIV is a blood-borne virus like hepatitis B. Similarly, if an analogical premise is only weakly warranted such as occurred, for example, during the BSE epidemic when scientists argued (incorrectly) that BSE and scrapie were related diseases, then we may

expect subjects to be disinclined to accept conclusions based upon this particular analogy.

Reasoning is influenced to a very large extent by the background knowledge that subjects bring to the problems they are assessing. It is expected that this background knowledge will affect the information that subjects attend to in the passages and the significance that subjects attach to this information. As Klahr (2000, p. 30) remarks: "When people are reasoning about real world contexts, their prior knowledge imposes strong theoretical biases . . . . These biases influence not only the initial strength with which hypotheses are held – and hence the amount of disconfirming evidence necessary to refute them – but also the features in the evidence that will be attended to and encoded."

To examine this effect in analogical reasoning, strong and weak analogies are portrayed in both actual and non-actual scenarios. The four public health scenarios that were used to examine analogical arguments are (a) the use of hepatitis B by the Centers for Disease Control in the US as a model for HIV/AIDS health advice,
(b) an investigation by environmental epidemiologists of illness related to chemicals in drinking water,
(c) the use of scrapie by British scientists to assess the risk of BSE to human health and
(d) a study by pharmacoepidemiologists of the health effects of a new arthritis drug.
The types of analogical arguments investigated in the study are shown below:

1. Strong analogy; actual scenario (public health scenario (a) above)
2. Strong analogy; non-actual scenario (public health scenario (b) above)
3. Weak analogy; actual scenario (public health scenario (c) above)
4. Weak analogy; non-actual scenario (public health scenario (d) above)

IIIB. Method

This study is part of a wider investigation of the role in public health reasoning of four informal fallacies (ignorance argument, authority argument, circular argument and analogical argument) (Cummings, 2014b, 2015a-b), but only the part of the study concerning circular argument and analogical argument is reported here.

Circular Argument Example

Each subject was presented with eight public health scenarios in the form of a written, postal questionnaire. There were three different versions of the questionnaire and each respondent completed only one version. Scenarios examining the fallacies were randomly distributed across the three versions of the questionnaire. The scenarios consisted of a single paragraph of information following which were four questions. Two of the questions required either a yes/no response or a response of a few words and could be answered on the basis of information explicitly presented in the corresponding passage. These questions were intended to give respondents the impression that they were engaging in a reading comprehension task. A third question was intended to establish if subjects accepted a particular circular argument. Subjects were required to rate a particular circular sequence as being valid, moderately valid or not valid at all. A fourth question asked subjects to explain their answer to the question probing circular argument and was intended to elicit an open response from which information could be gleaned about the factors that had been significant in the individual subject's reasoning.

The following passage and questions examined a circular argument with the features <virtuous circle: lack of evidence>:

Circular Argument Scenario

> Scientists at the World Health Organization (WHO) receive reports of a serious outbreak of illness in the Congo. The illness causes loss of appetite, intestinal

bleeding, severe breathing difficulties and a fatal pneumonia. Few people who develop the disease survive it. The symptoms are non-specific and are a feature of many diseases in the area. WHO's infectious disease scientists make a preliminary assessment of the situation and tentatively claim that a virus belonging to the Haemostriathus family may be responsible for the disease. WHO dispatches an emergency team of virologists, parasitologists and epidemiologists to the region in order to establish if one of the Haemostriathus viruses is responsible for the disease. Apart from reports of symptoms, these scientists have no evidence upon which to initiate their investigation. They are unable to obtain case histories from most of the victims, a large number of whom are dead or too seriously ill to be questioned. The scientists are therefore unable to determine if the victims of the disease were near water sources that are known to harbour Haemostriathus viruses. In the absence of evidence, they assume that a Haemostriathus virus is causing the disease and proceed to test the blood of hospitalised patients for the protein markers of these viruses.

Questions on Circular Argument Scenario

(1) The emergency team from WHO *assumed* that a Haemostriathus virus was the cause of the illness even as they were attempting to *establish* if this was the case. Please circle one answer to the following: was this strategy
(i) valid (ii) moderately valid
(iii) not valid at all?
(2) Please explain your response to (1).
(3) Where did the outbreak of illness occur?
(4) Were parasitologists part of the emergency team from WHO?

Analogical Argument Example

Analogical arguments were assessed using a similar format. As with circular arguments, four questions followed each passage. Two of these questions examined information presented in the passage and required either a yes/no response or a minimal response of just a few words. The question targeting the analogical argument in the passage asked subjects to rate a scientific response to a public health problem as valid, moderately valid or not valid at all. A fourth question asked subjects to explain their response to the question that probed analogical argument. The open-ended nature of the response was intended to reveal the types of factors to which subjects attached significance in rating an analogical argument.

The following passage and questions examined an analogical argument with the features <strong analogy + actual scenario>:

Analogical Argument Scenario

In 1981, reports of a rare form of pneumonia in five previously healthy homosexual males treated in three Los Angeles hospitals appeared in the Morbidity and Mortality Weekly Report in the United States. Little did the global scientific community know then that it was witnessing early cases of what was to become known as AIDS. Initially, the Centers for Disease Control (CDC) did not know what pathogen was responsible for this new disease. Before the HIV virus was even identified, the CDC issued advice on how the public could best protect itself against AIDS. This advice included information

about safe sex practices and the avoidance of needle sharing by intravenous drug users. The CDC's advice was based on its belief that the causal agent of AIDS must be a blood-borne virus given similarities between the population groups who were developing AIDS and those groups that were susceptible to another blood-borne virus, hepatitis B. These groups were homosexual males, intravenous drug users and recipients of blood transfusions. CDC scientists had extensive experience of the hepatitis B virus by the time the first cases of AIDS emerged. Consequently, they had little difficulty adapting public health information used for hepatitis B to address this new disease that confronted them.

Analogical Argument Questions

(1) Did the first cases of AIDS in the US appear in hospitals in San Francisco?

(2) The CDC believed that AIDS was caused by a blood-borne virus. Please circle one answer to this question: Was the CDC's belief (i) valid (ii) moderately valid or (iii) not valid at all?

(3) In which population group were the first five cases of AIDS documented?

(4) Please explain your response to (2).

All responses were written on the questionnaire which was completed anonymously. Subjects were informed that the task would take approximately 30 minutes to complete and that all data and responses were confidential. They were advised to undertake the exercise in a distraction-free environment and not to consult sources such as books and the internet, as questions were intended to elicit judgements from subjects rather than correct answers. A deadline for return of the questionnaire was communicated to all subjects. At the outset of the study, all scenarios were examined by two public health consultants and two academic linguists. This was done with a view to establishing, respectively, the plausibility (in public health terms) of the scenarios and the comprehensibility of the linguistic constructions used to characterize them.

IIIC. Subjects

A total of 879 subjects participated in the study. All subjects were between 18 and 65 years of age. Subjects could be male or female, of any ethnic or socioeconomic background and could be educated to either university level or secondary school level. The characteristics of all respondents to the questionnaire are shown in Table A in the Appendix. The three versions of the questionnaire received the same number of respondents: version A (293 subjects), version B (293 subjects), version C (293 subjects). Subjects were recruited to the study through a combination of methods. For the most part, the participation of subjects was secured through a series of formal recruitment activities which were undertaken in several venues, including public areas in local hospitals, staff dining facilities in large retail outlets and the lounge areas of private health clubs. A smaller number of subjects were recruited through a technique known as snowball sampling. In this technique, respondents to the questionnaire either offered to provide, or were asked to provide, the contact details of other individuals who might be willing to participate in the study. Questionnaires were subsequently sent to these individuals, some of whom recommended, in turn, other people who could participate in the investigation. *Snowball sampling* is a particularly effective way of recruiting subjects for a study when target groups are known to be inaccessible for a range of reasons (Browne, 2005). "A sampling procedure may be defined as snowball sampling when the researcher accesses informants through

contact information that is provided by other informants. This process is, by necessity, repetitive: informants refer the researcher to other informants, who are contacted by the researcher and then refer her or him to yet other informants, and so on. Hence the evolving "snowball" effect, captured in a metaphor that touches on the central quality of this sampling procedure: its accumulative (diachronic and dynamic) dimension" (Noy, 2008, p. 330).

It was predicted at the outset of the study that secondary school educated males would be particularly unwilling to participate in an investigation of this type. Level of formal education is almost certainly a key factor in the poor engagement of secondary school males in this study. However, another factor is likely to be the topic of the study. There is evidence that biological and health sciences are of less interest to men than the physical sciences. As a health-related discipline, public health science may simply not engage the interest of men sufficiently for them to want to engage in this study. (See chapter 7 in the Science and Engineering Indicators 2010 (National Science Board, 2010) for a detailed discussion of the role of formal education and sex in both interest in science and performance in surveys of scientific literacy.) Despite considerable efforts to recruit these subjects, the final recruitment figures revealed that secondary school educated males did indeed constitute an underrepresented group in the study: secondary school males (87 subjects), secondary school females (203 subjects), university males (205 subjects), university females (384 subjects).

TABLE 1: Circular argument

VIRTUOUS CIRCLE POSITIVE OUTCOME	**Results:** **Valid:** 57.9% **Moderately valid:** 29.8% **Not valid at all:** 12.3%
VIRTUOUS CIRCLE LACK OF EVIDENCE	**Results:** **Valid:** 28.6% **Moderately valid:** 43.5% **Not valid at all:** 27.9%
VICIOUS CIRCLE NEGATIVE OUTCOME	**Results:** **Valid:** 31.1% **Moderately valid:** 25.6% **Not valid at all:** 43.3%
VICIOUS CIRCLE ABUNDANT EVIDENCE	**Results:** **Valid:** 10.6% **Moderately valid:** 29.5% **Not valid at all:** 59.9%

TABLE 2: Analogical arguments

ANALOGY / SCENARIO	STRONG	WEAK
ACTUAL	**Strong analogy** **Actual scenario** **Results:** **Valid:** 51.4% **Moderately valid:** 41.3% **Not valid at all:** 7.3%	**Weak analogy** **Actual scenario** **Results:** **Valid:** 10.3% **Moderately valid:** 37.8% **Not valid at all:** 51.9%
NON-ACTUAL	**Strong analogy** **Non-actual scenario** **Results:** **Valid:** 49.1% **Moderately valid:** 41.5% **Not valid at all:** 9.4%	**Weak analogy** **Non-actual scenario** **Results:** **Valid:** 5.2% **Moderately valid:** 20.3% **Not valid at all:** 74.5%

IIID. Results

Full results for circular argument and analogical argument are displayed in Tables 1 and 2, respectively. Results for both types of argument are presented in this section.
A potentially significant trend was observed in the percentage of subject responses to the four passages examining circular arguments. There was a downward trend in the number of subjects who found circular argument to be a valid reasoning strategy as scientists increasingly overlooked evidence which was available to them. Subjects were most inclined to judge circular argument to be a valid reasoning strategy when it led to a positive outcome in a scientific investigation (57.9% valid) and were least inclined to judge it as valid when there was an abundance of conclusion-independent evidence which investigators failed to use (10.6% valid). Between these extremes, subjects were almost equally inclined to judge the argument as valid when there was a lack of conclusion-independent evidence available to investigators (28.6% valid) and when circular reasoning led to a negative outcome in an investigation (31.1% valid). There was an even clearer, downward trend in the number of subjects who judged circular argument to be not valid at all as the evidence available to scientists lessened and as investigations were shown to result in a positive outcome. The percentage of subjects who judged circular argument to be not valid at all was as follows: 59.9% (abundant evidence available to investigators), 43.3% (negative outcome to inquiry), 27.9% (lack of evidence available to investigators), and 12.3% (positive outcome to inquiry).

Data were analyzed using the Statistical Package for the Social Sciences (SPSS for Windows Version 18.0). Where there was no expectation of a difference between two variables, this was largely confirmed by a large Pearson chi-square value. For example, it was predicted that subjects would judge the use of circular argument to be equally unacceptable when a scientific investigation had a negative outcome and when abundant evidence was available to investigators but was overlooked by them. It was expected that subjects would judge the occurrence of the argument under both of these epistemic conditions to be equally unacceptable, hence the original designation of these circular arguments as "vicious circles." This was confirmed by a large Pearson chi-square value of 31.756. This value exceeds 0.05, indicating that there was no statistically significant difference in the <negative outcome> and <abundant evidence> variables.

It was also expected that subjects would judge circular argument to be equally valid when a scientific investigation resulted in a positive outcome and when there was a lack of evidence available to investigators; hence, the designation of circular argument under both epistemic conditions as "virtuous circles." Again, this was confirmed by a chi-square value of 3.028, which exceeds 0.05, indicating that there was no significant difference in how subjects rated circular arguments under these epistemic conditions. However, other, non-significant chi-square values were obtained for passage comparisons where a significant difference in subject responses might have been expected. They included comparisons between the epistemic conditions <positive outcome> and <negative outcome> (chi-square = 0.157), between <lack of evidence> and <abundant evidence> (chi-square = 6.721), between <negative outcome> and <lack of evidence> (chi-square = 0.172) and between <positive outcome> and <abundant evidence> (chi-square = 0.374). A possible explanation of these non-significant results will be considered in the discussion section.

There was also a potentially significant trend in the responses of subjects to the passages that examined analogical argument. Strong analogies were consistently rated as more valid by subjects than weak analogies. This was evident across both actual and non-actual scenarios. In this way, 51.4% of subjects rated a strong analogy as valid and only 10.3% rated a weak analogy as valid within an actual scenario. Within a non-actual scenario, a strong analogy was rated as valid by 49.1% of subjects and a weak analogy was rated as valid by 5.2% of subjects. The highest ratings of "not valid at all" were consistently found for weak analogies across both actual and non-actual scenarios. Weak analogies were rated as not valid at all by 74.5% of subjects (non-actual scenario) and 51.9% of subjects (actual scenario), while only 9.4% of subjects (non-actual scenario) and 7.3% of subjects (actual scenario) rated strong analogies as not valid at all. There appeared to be negligible percentage differences in subject ratings of validity across actual and non-actual scenarios. For example, responses to the passages which examine strong analogies were as follows: actual scenario (51.4% valid; 41.3% moderately valid; 7.3% not valid at all) and non-actual scenario (49.1% valid; 41.5% moderately valid; 9.4% not valid at all).

As with circular argument, responses to the analogical argument passages underwent statistical analysis. Large and non-significant chi-square values confirmed initial impressions of small and negligible percentage differences in subject responses to certain passages. For example, based on the above percentage figures, it appeared that subjects were largely insensitive to the <actual> and <non-actual> variables in the context of passages that contained strong analogies. This was confirmed by a chi-square value of 2.568, which exceeds 0.05, indicating that there was indeed no significant difference in these variables. However, where large percentage differences in subjects' responses occurred and

a finding of significant difference might have been expected, this did not come about. For example, 51.4% and 10.3% rated analogical reasoning as valid in passages that contained strong and weak analogies, respectively. Yet, a Pearson chi-square value of 1.554 was obtained for these passages. An explanation of these non-significant results is given in the discussion section.

Statistical analysis of a subset of the data using the Pearson chi-square test indicated that there were no significant differences in reasoning based upon the gender and education level of respondents. (See Table B in the Appendix.) This confirms in part the findings of an earlier study which failed to find an effect of age and gender on the type of information processing (systematic versus heuristic) used by subjects during their assessment of epidemiological information about cancer rates (Trumbo, 2002). Given this lack of significant differences, and the fact that subject attributes such as age, gender and education are not central to the questions posed by this study, it was decided not to conduct further statistical analysis of the effects of gender and education level on subjects' reasoning.

IV. Discussion

This study has revealed a previously untested rational competence on the part of lay people as they attempt to form judgements about public health problems. In this first experimental investigation of the informal fallacies, subjects were found to be adept at recognizing the epistemic conditions under which circles and analogies in reasoning were more and less rationally warranted. Subjects were able to identify when analogies are sufficiently robust to provide strong rational warrant for a particular public health intervention (e.g. the dissemination of public health information on HIV based on an analogy with hepatitis B). Where an analogy was weak or flawed in some respect, subjects consistently identified the source of this weakness and rejected risk assessments and public health measures which were based upon it (e.g. the use of an analogy with scrapie in risk assessments about BSE). Moreover, these judgements were in evidence in actual and non-actual scenarios. This suggested that subjects' judgements about public health problems are the manifestation of a stable rational competence. Specifically, they are *not* the consequence of the unique features that attend any particular public health problem.

By the same token, subjects identified some circles in reasoning as valid, while other circles were considered to be dubious value and were accordingly rated as not valid at all. Valid or "virtuous" circles in reasoning were those which enabled scientists to achieve a positive outcome in inquiry, where such an outcome may be the confirmation of a hypothesis about the cause of an illness in a population. Also, circles in reasoning were characterized as valid by subjects when scientists lacked evidence which was independent of the conclusion-to-be-proved. When either situation did *not* obtain, that is, when an inquiry either had a negative outcome or there was available evidence that was overlooked by scientists, subjects consistently judged these circles in reasoning to be not valid at all (they were "vicious" circles).

Furthermore, these judgements were not dependent on a particular public health problem or scenario – scenarios as wide-ranging as the emergence of a new disease in a tribal population and the possible side effects of a vaccination for pneumonia were equally likely to give rise to these judgements. The consistency of these judgements across different scenarios once again suggests that subjects are drawing upon a stable rational competence in their reasoning.

This study provides tentative evidence for the claim that subjects are able to use analogical and circular arguments to bridge gaps in their knowledge during reasoning about complex public health problems. Both

analogical and circular arguments functioned for these subjects as quick rules of thumb or heuristics which guided judgement-making under specific epistemic conditions. These conditions were adverse in some respect with scientists attempting to assess public health risks and institute public health measures in the absence of evidence and knowledge (of a new pathogen, for example). Under these conditions, circles and analogies were found to have a facilitative function in reasoning through their capacity to bridge gaps in subjects' knowledge. Rather than suspend judgement in the absence of knowledge – an unwise cognitive policy in the public health domain where there are potentially serious consequences of inaction for human health – subjects put into effect reasoning strategies which helped them to arrive at judgement about some quite complex scientific issues. Under more favourable epistemic conditions, it is likely that these strategies would be found wanting in a number of essential respects. However, when confronted with epistemic uncertainty, subjects are clearly willing to embrace these traditionally fallacious arguments.

A qualitative analysis of the extended responses of subjects to the passages in the questionnaire supports the claim that subjects are sensitive to the epistemic conditions under which analogies and circles in reasoning are more and less rationally warranted. Strong analogies elicited comments to the effect that scientists were drawing "scientifically based" connections between an existing and a new disease and that it was "logical" or "a good starting point" to use existing knowledge in drawing conclusions about a new public health problem. The rational force of analogical reasoning was widely acknowledged by subjects to consist in the extent to which the chemicals and diseases described in the passages were similar in nature:

Strong analogies:
"The CDC [Centers for Disease Control] noticed the similarities between AIDS and hepatitis B and the population groups susceptible to both diseases" (White female, 49 years old, secondary school educated)
"the CDC would seem to have made a scientifically based connection between an existing disease and a new one" (White female, 49 years old, university educated)
"I think it was a good starting point as the chemical compound in question was identified as being similar to the chemical identified in causing the ailments stated" (Black Carribean female, 29 years old, university educated)
"It seems logical to use existing knowledge about another similar chemical to investigate whether the second chemical was the source of the health problems in the area" (White female, 29 years old, university educated)

Subjects were equally adept at articulating their reasons for rejecting weak analogies. These reasons included comments to the effect that "related" diseases could still act differently. As such, it was "not conclusive" and was not a "safe assumption" to base a conclusion about the transmissibility of one disease (BSE) to humans on the lack of transmissibility of another disease (scrapie) to humans. Indeed, to do so was characterized as "flawed reasoning." A lack of similarity between two diseases (and two chemicals) was clearly identified by subjects as casting doubt on the rational force of the weak analogies in the passages:

Weak analogies:
"They based an opinion about a 'new' disease on the action of a 'different' disease. This is not conclusive" (White male, 38 years old, secondary school educated)
"At this time it was not conclusive that BSE and scrapie were related diseases – it was only a suggestion, therefore the reasoning behind the suggestion that BSE would not transmit to humans was flawed" (White female, 32 years old, university educated)
"it doesn't seem to me a safe assumption that because two diseases are 'related' they

will necessarily act in the same way as far as transmission to humans is concerned" (White male, 62 years old, university educated)
"The drugs had different chemical compositions and therefore may not have been similar enough to draw that conclusion" (White female, 32 years old, university educated)

In relation to circular arguments, an equally rich array of expressions was used by subjects to justify their judgements about the reasoning in the passages. Virtuous or valid circles were described in terms of good scientific method such as when the outcome of an inquiry provided confirmation of a scientific hypothesis. Virtuous circles were also characterized as a type of "better than nothing" reasoning, when scientists had "no real option" other than to use conclusion-dependent evidence in order to advance an investigation. In both cases, practical considerations such as the time taken to conduct investigations and the urgency of a public health problem (highlighted in the occurrence of deaths, for example) were seen to justify reasoning which, under other circumstances, might not be judged in such favourable epistemic terms. (Nicholas Rescher has discussed *faute de mieux* (for lack of anything better) considerations in cognition and reasoning. See Rescher (2009) for an account of presumption in this context.)

Virtuous circles:
"All science is based on an assumption which is then used to determine testable hypothesis which can be used to prove or disprove the assumption" (White male, 25 years old, university educated)
"It's the most obvious explanation and lends itself to easy, quick verification. Time was obviously of the essence in this case" (White male, 56 years old, university educated)
"In the situation described (i.e. no clear evidence) the scientists have no real option other than to set up what to their judgment (on the basis of their initial preliminary assessment of the situation) was a reasonable hypothesis and to test it" (White male, 62 years old, university educated)
"They had nothing else to go with. They had to make the assumption to test the hypothesis" (White male, 55 years old, university educated)
"The assumption could lead to others being monitored closely to prevent further deaths" (White female, 48 years old, university educated)

Passages which contained vicious circles elicited an equally wide-ranging set of evaluative comments from subjects. Vicious circles were described as examples of bad science or poor scientific method. Subjects stated that these circles were problematic because scientists overlooked evidence and did not consider other possible causes of diseases. Some subjects identified the reasoning as a type of "circularity," the latter term used in a strictly pejorative sense. (It is worth noting that no subject in the study used the term "circularity" in a positive epistemic sense. The standard meaning of this term appears to reflect its largely negative characterization in traditional logical literature.)

Vicious circles:
"blinkered approach…these people were trying to establish a cause, not exclude a particular option. Very bad science" (White male, 42 years old, university educated)
"As they had prior assumptions about the cause of the disease, this may have influenced their methodology and also biased their results as they may have unknowingly fit the data to their assumptions to get the results they expected" (White female, 26 years old, university educated)
"All possible causes should have been considered (say, genetic, chemical contamination, etc.)" (White male, 63 years old, university educated)
"it may have prevented/hampered an adequate search for an alternative cause" (White male, 50 years old, university educated)

"Assumption leads to a circularity → if it's what you expect to find and disregard all other sources of evidence, it will be what is found" (White female, 45 years old, university educated)

Although the percentage figures obtained in this study suggest a number of clear trends in how subjects rated the analogies and circles in the passages, these were not supported by significant chi-square values. The lack of significant chi-square values in this study may be attributed to a couple of factors. Firstly, public health studies that examine human judgements typically employ a sample in excess of 1,000 subjects. This study obtained responses from 879 subjects. Despite extensive efforts to recruit more subjects, it was simply not possible to do so. Many subjects agreed to participate in the study, but did go on to complete and return the questionnaire. Some individuals reported that this was on account of the amount of time and degree of effort which was needed to complete the exercises. Other public health studies have tended to use shorter questionnaires in which subjects merely tick boxes or circle responses. Also, these studies often offer subjects a financial inducement for their participation. This was simply not possible within the resource constraints of the current investigation. It is likely that with a larger number of subjects, several chi-square values that approached significance would have fallen below the 0.05 significance level. Secondly, the test format required subjects to indicate one response from the following possible responses: (a) valid, (b) moderately valid, (c) not valid at all. It is possible that the use of three response categories weakened trends in the subjects' responses in terms of the statistical analysis. A simpler test format that made use of just two response categories (valid and not valid) may have resulted in statistically significant results. Certainly, these factors could be addressed in any further study in the area.

An experimental study of this type must ultimately contribute to the development of theoretical frameworks that can be used to explain the heuristic reasoning processes at work in public health and other contexts. Certainly, the heuristic processing models that informed the risk assessment studies (see Section II) of Trumbo (2002) and Johnson (2005) seem powerless to accommodate the specific emphasis on informal fallacies as cognitive heuristics addressed in this paper. However, recent work by Douglas Walton is at least suggestive of what a theoretical account of fallacies-as-heuristics might look like. According to Walton (2010), most of the informal fallacies are associated with an argumentation scheme and a corresponding parascheme. The argumentation scheme is part of a newer (in evolutionary terms) cognitive system which operates in a controlled, conscious and slow manner. This scheme asks critical questions of arguments, questions which are likely to expose logical weaknesses, if such weaknesses exist. The parascheme is a shorter version of the argumentation scheme. It is part of an older cognitive system which uses fast and frugal heuristics to achieve solutions to problems. Some of these heuristics involve jumping to conclusions, a cognitive strategy that can work well enough on some occasions but results in errors on other occasions. Walton demonstrates this heuristic view of the fallacies in relation to the argument from expert opinion (argumentum *ad verecundiam*). The parascheme of this argument omits assumptions, exceptions and one ordinary premise that are integral to the corresponding argumentation scheme. By neglecting these aspects, which confer a slow, deliberative character on reasoning, an arguer can employ a fast heuristic to the effect "if it's an expert opinion, defer to it" (Walton, 2010, p. 170).

Walton's approach has certain benefits for the view of fallacies presented in this paper. It achieves an important cognitive reorientation of the informal fallacies. This is a *sine qua non* of an account of the fallacies that construes them as *cognitive* heuristics which

have a facilitative function in public health *reasoning*. Notwithstanding its cognitive emphasis, Walton's approach retains a strong normative character such that informal fallacies are evaluated against the need to consider assumptions and exceptions which are typically bypassed by their corresponding heuristics: "To judge whether an alleged argument from ignorance is fallacious the heuristic has to be examined in relation to whether other assumptions and exceptions need to be taken into account that may be acceptable or not" (Walton, 2010, p. 178). Yet, these merits of Walton's approach must be considered alongside a couple of notable difficulties. One of the fallacies we have examined in this paper, circular argument--also known as *petitio principii* or begging the question--is one of several fallacies which Walton (2010, p. 175) admits "do not appear to fit specific argumentation schemes, or benefit directly from schemes when it comes to analyzing them." In contrast, false analogy is amenable to analysis in terms of argumentation schemes. Also, on the account of fallacies presented in this paper, heuristics are not a matter of bypassing critical questions which attend an argumentation scheme (à la Walton), but rather they are mental shortcuts through a domain of expert knowledge which is beyond the cognitive grasp of the lay person. If anything, the results of this study suggest that people in fact do address, rather than bypass, critical questions when they engage in heuristic reasoning. It remains to be seen if Walton's approach can accommodate difficulties of this type and one or two others discussed in Cummings (2012a). In the meantime, it is a firm basis upon which to build a theoretical account of a heuristic-based approach to the fallacies.

Quite apart from the logical and theoretical lessons of this investigation, there are also lessons for public health practitioners from the current study. This study has shown that the informal fallacies are capable of doing some important cognitive work in the public health domain. Given that subjects are reasonably adept at recognizing the conditions under which circles and analogies in reasoning are more and less rationally warranted, public health practitioners should begin to exploit this valuable cognitive resource in their communications and interventions with the public. Public health communications with members of the public are frequently ignored, rejected or misunderstood. This results in poor compliance with a large range of measures which are designed to protect human health. Cases in point are the low uptake of vaccinations (e.g. measles, mumps, rubella (MMR), influenza) and the widespread neglect of measures which protect against the spread of infectious diseases (e.g. sexually transmitted infections). To the extent that lay people recognize the conditions under which circles and analogies in reasoning are more and less rationally warranted and are prepared to put this knowledge to use in making judgements about public health problems, it would seem eminently reasonable for practitioners in the public health field to frame messages and advice with these cognitive strategies in mind.

Public health practitioners should also be aware of one further and very important lesson for their field from the current study. That lesson is that a lack of knowledge is *not* the same as a lack of reasoning. Certainly, lay people do not have the knowledge of expert scientists in the public health domain and other scientific areas. There is no doubt, therefore, that they experience a lack of knowledge. But if this study demonstrates one thing it is that even lay people are capable of bringing to an assessment of public health problems a rich array of reasoning strategies which serve them well in arriving at judgements about those problems. It would be a serious mistake for public health practitioners to confuse a lack of knowledge on the part of lay people with a lack of reasoning and then proceed to construct public health communications and advice on this basis. The result would be a series of interventions which fail to engage with the

rational cognitive strategies of the very people – members of the public – whose compliance is most needed in order to undertake effective public health work. So, in conclusion, it can be said that public health practitioners should certainly exploit the informal fallacies examined in this study. But a policy of actively circumventing these arguments is guaranteed to lead only to poor compliance with protective health measures on the part of the public.

V. Summary

This study is part of the first experimental investigation of a group of arguments called the informal fallacies in public health reasoning. These arguments have traditionally been examined by logicians and philosophers whose principal concern has been to describe their logical and epistemic features. The ability of lay people to recognize these features and employ these arguments as heuristics during reasoning about public health issues has not previously been considered by investigators. The study provides tentative evidence that lay subjects are adept at recognizing the conditions under which circular and analogical arguments are more and less rationally warranted. Moreover, they are capable of exercising this rational competence in order to arrive at judgements about complex public health problems. This finding has implications for recent theoretical models of the informal fallacies as cognitive heuristics. However, beyond the logical and theoretical implications of the current study, there are also implications for public health practitioners. To the extent that members of the public possess this particular rational competence and can apply it to public health problems, practitioners in the public health field, it is argued, should seek to exploit this competence in their communications with the public.

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Appendix

TABLE A: Subject characteristics

	SUBJECT CHARACTERISTICS (total = 879 subjects)
AGE	Average: 43.8 years Range: 18-65 years
GENDER	Male: 292 subjects Female: 587 subjects
EDUCATION	University level: 589 subjects Secondary school level: 290 subjects

TABLE B: Argument type: sex and education level (university/secondary)

ARGUMENT TYPE	Response	Sex	Education
		M/F	Uni/Sec
Analogical argument: **Strong analogy** **Actual scenario**	Valid: Moderately valid: Not valid at all:	49.4/52.2% 43.4/40.5% 7.2/7.3%	49.2/56.0% 43.7/36.3% 7.1/7.7%
Analogical argument: **Strong analogy** **Non-actual scenario**	Valid: Moderately valid: Not valid at all:	40.4/49.7% 48.2/42.3% 11.4/8.0%	44.2/49.0% 45.8/42.9% 10.0/8.1%
Analogical argument: **Weak analogy** **Actual scenario**	Valid: Moderately valid: Not valid at all:	7.8/12.0% 36.5/38.6% 55.7/49.4%	6.8/17.2% 40.6/32.3% 52.6/50.5%
Analogical argument: **Weak analogy** **Non-actual scenario**	Valid: Moderately valid: Not valid at all:	8.6/3.6% 19.4/20.8% 72.0/75.6%	4.1/7.4% 21.0/18.9% 74.9/73.7%
Question-begging argument: **Virtuous circle** **Positive outcome**	Valid: Moderately valid: Not valid at all:	61.0/56.7% 25.6/31.5% 13.4/11.8%	59.4/54.6% 27.4/35.2% 13.2/10.2%
Question-begging argument: **Virtuous circle** **Lack of evidence**	Valid: Moderately valid: Not valid at all:	33.9/25.9% 43.5/42.9% 22.6/31.2%	30.0/27.4% 44.7/40.0% 25.3/32.6%
Question-begging argument: **Vicious circle** **Negative outcome**	Valid: Moderately valid: Not valid at all:	39.1/27.4% 21.8/27.4% 39.1/45.2%	34.9/23.5% 26.2/24.5% 38.9/52.0%
Question-begging argument: **Vicious circle** **Abundant evidence**	Valid: Moderately valid: Not valid at all:	10.9/10.5% 29.3/29.5% 59.8/60.0%	12.3/7.2% 27.2/34.0% 60.5/58.8%