

Judging question answerability

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Dedicated to my dear mother

Doctoral Dissertation in Psychology

Abstract

This thesis investigates a specific type of judgments, answerability judgments, that is the judgment if anyone can provide a correct answer to a particular question. Answerability judgments are important since they may affect other important decisions regarding e.g., climate change and medical and legal decision making. Four studies were performed. **Study I** compared participants' ratings of the answerability of three types of general knowledge questions. Both current answerability (whether the question was currently answerable by someone) and future answerability (whether the question could be answered in the future) were measured. **Study II** compared pairs and individuals on answerability judgments on general knowledge questions. **Study III** investigated judgments on whether 'I', 'somebody else', or 'nobody' could answer general knowledge questions. In **Study IV** answerability judgments on the colours of an ambiguous viral photograph, The Dress, were investigated. Self-report measures of individual differences were also conducted in Studies I, III, and IV.

The results from the studies suggest that social influence is important when judging question answerability. Data suggest that people often judge answerability in line with their beliefs about what most relevant others believe. This is called the consensus effect.

However, individual differences also explained variation in answerability judgments especially when consensus about the question's answerability was lacking. People with higher scores on certainty beliefs, mankind's knowledge, mankind's efficacy, and preference for default processing, more often rated general knowledge questions as being more answerable. On the other hand, higher scores on personal optimism and need for cognition was associated with more choices of 'nobody can answer'.

Questions that were considered more answerable today were also often judged to be possible to answer in a closer future suggesting that judgments of answerability may include judgments of psychological distance. Furthermore, the result suggests that a feeling of higher answerability can be created, through contextual associations, even when it is unlikely that somebody can come up with an answer. Lack of consensus was associated with lower answerability judgments.

Svensk sammanfattning

Bakgrund och övergripande syfte

Är det farligt att använda mobiltelefon? Är den anklagade verkligen skyldig? Finns det ett säkert sätt att lagra använt kärnbränsle? Kan man verkligen säga att det finns ett klimathot? Ibland kan viktiga frågor anses svåra att svara på. Till och med så svåra att en person kan ifrågasätta om det över huvud taget finns någon människa som någonsin kan komma med ett säkert svar, dvs om frågan är *besvarbar*. Bedömningar av frågors besvarbarhet är viktiga att studera eftersom sådana bedömningar kan påverka andra viktiga beslut som kan få konsekvenser för individ och samhälle, t.ex. hur stora insatser som behövs för att minska global uppvärmning eller vilka produkter som ska förbjudas av hälsoskäl. Detta innebär, att trots att bedömningar av frågors besvarbarhet ibland kan vara svåra att göra, är det ändå viktigt i många sammanhang att sådana bedömningar blir realistiskt gjorda.

Även om denna typ av bedömningar är viktiga finns inte mycket forskning gjord på hur det egentligen går till när människor kommer fram till om, och i så fall när en fråga kan besvaras. Vad påverkar bedömningarna? Finns det t.ex. vissa typer av frågor som tenderar att bedömas som mer möjliga att besvara än andra? Blir bedömningarna olika om de görs i grupp eller individuellt? Finns det människor som tror att frågor i allmänhet har svar? Och går det att få frågor att verka mer eller mindre besvarbara än de verkligen är? För att börja undersöka en del av dessa frågeställningar (och några andra) gjordes fyra studier. Tidigare forskning har främst undersökt om man själv är säker på sitt eget svar, och inte så mycket om man tror att någon överhuvudtaget kan svara (undantaget viss forskning av t.ex. riskbedömningar). När det gäller besvarbarhetsbedömningar är det troligt att en person börjar med att fråga sig själv om denne tror sig kunna svaret. Om så inte är fallet kan personen börja fundera över om någon annan kan svaret eller kan komma fram till ett svar inom en rimlig framtid. Denna avhandling har i fyra olika studier utforskat människors bedömningar av frågors besvarbarhet.

I **Studie I** bedömde 476 deltagare 22 frågor med avseende på om de var möjliga att besvara av någon nu levande människa, idag eller i framtiden (idag, om ett år, om två år, 10 år, etc.). De 22 frågorna var indelade i tre kategorier: konsensusfrågor (där forskarna antog att majoriteten av svenska folket tror att frågan är besvarbar), icke konsensusfrågor (där forskarna antog att majoriteten av svenska folket tror att frågan inte är besvarbar) samt illusionsfrågor. Illusionsfrågorna var beräkningsfrågor där en variabel

fattades för att beräkningen skulle kunna utföras. Konsensusfrågorna upplevdes som mest besvarbara, därefter illusionsfrågorna och sist icke-konsensus frågorna. En del deltagare trodde att vissa frågor aldrig skulle kunna besvaras. Två skalor användes, en där deltagarna fick bedöma om någon kunde besvara frågorna i dag, och en skala där deltagarna fick bedöma när (om någonsin) någon kunde besvara frågorna. Frågor som upplevdes som mer besvarbara idag bedömdes också kunna bli besvarade i en mer snar framtid.

Individuella skillnader i bedömningar av besvarbarhet undersöktes också. Personer som trodde på säker kunskap och på mänsklighetens förmåga att kunna lösa problem bedömde icke-konsensus frågorna som mer besvarbara. Mer optimistiska personer trodde i större utsträckning att icke-konsensus frågorna inte kunde besvaras av någon idag. Deltagare som antog att illusionsfrågorna var besvarbara föredrog en kombination av en mindre intellektuell och mer intuitiv tankestil.

Studie II jämförde par och individer på besvarbarhetsbedömningar. Trettioen individer och trettio par gjorde besvarbarhetsbedömningar av 20 allmänna kunskapsfrågor (fyra konsensusfrågor och sexton icke-konsensus frågor). Paret gav högre besvarbarhetsbedömningar än individerna på frågor med bedömd besvarbarhet på över 80%, och lägre besvarbarhetsbedömningar än individerna för frågor med lägre besvarbarhet än 80%. Förklaringen därtill är troligen att paret eftersträvar konsensus och att söka konsensus är en viktigare del av besvarbarhetsbedömningen för paret än för individerna.

Studie III undersökte deltagares uppfattning om vem som kunde besvara allmänna kunskapsfrågor. Totalt 123 deltagare bedömde 46 allmänna kunskapsfrågor och fick svara på om de själva, någon annan eller ingen kunde svara på frågorna. Det var 26 konsensusfrågor och 20 icke-konsensus frågor. Innan varje fråga fick hälften skatta sin egen kunskap om frågan. Alternativet ”ingen kan svara” valdes mer ofta för icke-konsensusfrågorna än för konsensusfrågorna. Deltagarna som fick skatta sin kunskap innan de gjorde bedömningarna valde mer sällan ”ingen kan svara”. Detta kan bero på att kunskapsskattningarna aktiverade minnen som gjorde att deltagarna tänkte på möjligheten att någon kan besvara frågan. Deltagare som trodde på möjligheten av säker kunskap i allmänhet, och hade högre maximeringstendenser (dvs försöker hitta bästa möjliga beslutsalternativet, inte bara ett som är tillräckligt bra) svarade oftare ”någon annan vet” på icke-konsensus frågorna. Deltagare med en preferens för att ägna sig åt tankeverksamhet (hög ”need for cognition”), valde mer sällan ”någon annan vet” för både konsensus och icke-konsensus frågor. Detta kan förklaras genom att personer med preferens för att ägna sig åt tankeverksamhet skulle kunna vara mer benägna att acceptera att det finns frågor som inte har svar, i

kombination med att dessa personer är svårare att övertyga om de redan skaffat sig en personlig uppfattning.

I **Studie IV** undersöktes besvarbarhetsbedömningar av färgen i ett tvetydigt färgfotografi av en klänning (det virala fenomenet #TheDress). Fotografiet blev ett viralt fenomen i början av 2015 på grund av att vissa personer såg en blå och svart klänning medan andra såg en klänning i vit och guld på samma fotografi. Totalt svarade 186 personer på tre frågor 1) om de hade sett bilden förut, 2) vilka färger de såg (blå/svart; vit/guld; annat, nämligen) och 3) vilka färger de trodde var rätt svar (blå/svart; vit/guld; annat, nämligen; det finns inget rätt svar). Personerna skattade också hur pass optimistiska de var. Alternativet ”det finns inget rätt svar” tolkades som att frågan inte var besvarbar. Personer som hade mer erfarenhet av fotografiet trodde att det fanns ett rätt svar i högre utsträckning än de som såg det för första gången. De som var mer optimistiska trodde i högre utsträckning att det inte fanns något rätt svar om färgen på klänningen. En intressant iakttagelse var också att 19% av de som hade sett klänningen förut såg klänningen som vit och guld, men trodde att blå och svart var rätt svar. Detta visar i linje med aktuell minnesforskning att människor ibland inte tror på det de ser och minns.

Slutsatser och framtida forskning

Sammantaget visar studierna på att bedömningar av besvarbarhet är viktigt att se i det sociala sammanhang där bedömningen görs. Resultaten från de fyra studierna föreslår att människor ofta väver in vad andra tror om frågans besvarbarhet i sin egen bedömning av frågans besvarbarhet, dvs ”tror de flesta andra att frågan är besvarbar så tror jag också det”. Konsensus eller brist på konsensus om frågans besvarbarhet kan alltså vara ett viktigt kriterium när människor bedömer en frågas besvarbarhet. Vilken effekt som föreställningar om enhetligheten i andras åsikter om svaret på en fråga har på besvarbarhetsbedömningar kan variera beroende på omständigheterna. När föreställningen är att andra är överens om frågans svar, eller om att frågan kan besvaras, så kan detta dock i allmänhet tänkas leda till att frågan bedöms som mer besvarbar. Även andra faktorer än föreställningar om konsensus kan naturligtvis tänkas påverka bedömningar av besvarbarhet. När det inte finns någon konsensus om frågans svar eller dess besvarbarhet tycks individuella skillnader i kunskapsyn, tro på mänskligheten och personlig optimism vara relaterade till bedömningarna. Resultaten visar även att det är möjligt att skapa en känsla av att ”någon annan vet” även om det troligen inte är så.

Resultaten från Studie II tyder på att effekter av föreställningar om konsensus kan öka när besvarbarhetsbedömningarna görs i par istället för individuellt.

Studierna visade även att individuella skillnader i bland annat kunskapssyn och optimism kan påverka besvarbarhetsbedömningar. Personer med en hög tro på säker kunskap och hög tro på mänsklighetens visade i i studie I och III en ökad tro att frågor har svar. Optimister visade en tendens att säga att frågan inte kan besvaras idag. Personlighetsdragen Maximeringstendenser (en beslutsfattande stil där personen försöker optimera sina val) och "need for cognition" (en intellektuell tankestil) var relaterad till bedömningar av vem (om någon) som kan besvara frågan.

En relativt ny psykologisk teori, den s.k. construal level theory, handlar om bedömningar av "*psykologiskt avstånd*". Denna teori menar att människor gör bedömningar av psykologiskt avstånd till, till exempel framtida händelser, det geografiska avståndet till en plats, eller det fysiska avståndet till en annan människa. Bedömningar av kort psykologiskt avstånd ligger på en lägre konstrual level och är mer detaljerade och tydliga, medan en hög construal level är mer abstrakt. Construal level theory menar att bedömningar av tid till en händelse och avstånd i rummet kan ha gemensam nämnare, nämligen psykologiskt avstånd. Det statistiska sambandet mellan framtida besvarbarhet och nutida besvarbarhet som framträdde i studie I, ger stöd för att besvarbarhetsbedömningar kan innehålla bedömningar av det psykologiska avståndet från det egna självet till det korrekta svaret. Resultaten från Studie IV, att vissa människor inte tror att de färger de själva ser, inte nödvändigtvis är det korrekta svaret, tyder också på att det besvarbarhetsbedömningar kan innehålla flera alternativa bedömningar av avståndet från det egna självet till en eller flera alternativa korrekta svar och att ytterligare en bedömning som avgör vilket alternativ som är mest troligt. Då metakognition förenklat kan beskrivas som tankar om tankar, kan bedömningen av vilket alternativ som är mest troligt beskrivas som en metakognitiv bedömning.

Framtida forskning får utvisa om resultaten från denna avhandling kan replikeras för andra grupper av människor och för andra frågor. T.ex. vore det av intresse att tillämpa det ramverk som byggts upp i denna avhandling för att undersöka besvarbarhetsbedömningar i tillämpade sammanhang, t.ex. inom vården och hållbar utveckling. Begreppet besvarbarhet kan också ge nya perspektiv till grundforskning gällande minne och kognition. Bifunden från studie IV, att människor ibland inte tror på de färger de ser visar tydligt på att den mänskliga perceptionen inte är en objektiv inspelning av omvärlden. Detta väcker grundläggande frågor om relationen mellan seende, tänkande och bedömningar av verkligheten. Är själva seendet en bedömning? Och innefattar denna bedömning också en bedömning av besvarbarhet som

varierar stabilt mellan individer? Begreppet besvarbarhetsbedömning ger viktiga infallsvinklar till såväl grundläggande forskning inom perception, kognition som praktiska bedömningar i vardagliga sammanhang i arbetsliv och privat.

Acknowledgements

The image of an iceberg on the front page of this dissertation has three important meanings to me in relation to my thesis. First, it is a symbol of research into people's beliefs about the answerability of climate change questions in a debated area of sustainability, where answerability judgements have been discussed in the media, in top-level politics, and in science.

Second, the iceberg is a symbol of the original project proposal submitted by my supervisor, Professor Carl Martin Allwood, concerning judgements of ignorance. This project was approved by the Swedish Scientific Council, and without their generous support this thesis would not have been possible. Within the framework of ignorance judgements, the seed of answerability judgements grew into this thesis.

Finally, the iceberg symbolises all the work that is not visible in this thesis, but necessary to carry it above the surface. For every word written, several deleted versions languish in the bin of my computer; for every published paper, several versions were rejected. Every study required pre-studies, meetings, and preparations, and virtually nothing was done in isolation: My name on this thesis is just the tip of the iceberg of social context that fostered, facilitated, and developed these ideas.

First, I would like to thank my supervisor, Carl Martin Allwood, for the opportunity to research and write this thesis. I learned so much from you during this time, and I am extremely grateful. You provided words for things I only vaguely felt and could hardly explain. Sometimes you put a book or an article in my hand before I had even formulated the question. Thank you for all your acts of care and concern for my academic development. In you I met a person who genuinely seeks answers to difficult questions, putting great effort into doing what you believe in and never giving up. Meeting you reminded me more than anything of the importance of things that are timeless. Supervision was always a priority for you and I am very grateful for all the hours we spent together. These discussions sharpened my mind. I am also glad for your support and for the confidence you had in me as I was developing some of my own contributions and ideas within the frame of this project.

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Gro and Magnus: your names have been mentioned more than once, and that is not a coincidence. Magnus thank you for “infecting” me with your inspiring Friday night experiment mood and intellectual discussions when we shared rooms. And Gro Einarsdottir, thank you for being such an engaged, supportive, intelligent, and humorous person, turning coffeebreaks into fika summits. It is impossible to be bored when you are around. I would also like to acknowledge all my friends and relatives who took the time and were patient enough to fill in trial-versions of questionnaires, read texts, listen

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Preface

This thesis is based on the following four papers, referred to by their Roman numerals.

- I. Karlsson, B. S. A., Allwood, C.M., & Buratti, S. (2016). Does anyone know the answer to that question? Individual differences in judging answerability. *Frontiers in Psychology*, *6*, 2060. doi: 10.3389/fpsyg.2015.02060.
- II. Allwood, C. M., Karlsson, B. S. A., & Buratti, S. (2016). Does consulting with others affect answerability judgments of difficult questions? *Social Influence*, *11*, 40–53.
- III. Buratti, S., Allwood, C. M., Karlsson, B. S. A. (2017). Who knows? Knowledge activation, belief in certainty of knowledge, maximization tendencies and need for cognition in answerability judgments. *The Journal of General Psychology*, *144*(1), 35-58.
- IV. Karlsson, B. S. A., & Allwood, C.M. What is the correct answer about the Dress colors? Investigating the relation between optimism, previous experience and answerability. *Frontiers in Psychology*, *7*, 1808. doi: 10.3389/fpsyg.2016.01808.

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Introduction

Imagine a patient asking a doctor: ‘Will the recommended surgery cure my disease?’ The surgery usually succeeds, but complications can occur. Can the patient be given a correct, well-argued answer to this question at the time it is asked? In court, the most important question is whether the evidence proves a person’s guilt ‘beyond a reasonable doubt’. But what if the evidence is scarce, witnesses disagree, and the defendant is mentally ill? Can the question of guilt be given a reasoned, correct answer on the basis of the available evidence? In relation to climate, politicians have asked whether researchers can provide a correct answer to questions like ‘Is global warming caused by humanity?’. The question ‘Is global warming a severe threat for human survival on Earth?’ has also been debated.

Many important questions, asked in the context of individual and societal decision making, are difficult to answer. It may also be hard to judge whether a correct answer is currently, or will ever be, available to anyone. It can also be argued that the nature of all things is uncertain (ontological uncertainty) and therefore specific types of questions may be impossible ever to answer. It can also be argued that answers may exist, but be out of reach of human knowledge (epistemological uncertainty) now or in the future (Rescher, 2009). A judgment about whether any person (including oneself) could ever answer a question correctly is an *answerability judgment*¹.

Answerability judgments may be made on an individual, personal level for everyday decisions such as ‘Is it possible to repair this?’, ‘Is it safe to use a cellphone every day?’, or ‘Is he truly happy?’ Answerability judgments can also be made on an organisational or societal level, for instance for questions such as: ‘Can this consultancy service help our company?’, ‘Is there a safe way to store nuclear waste?’, or ‘How much will the new transportation system cost?’ Answerability judgments may include judgments about one’s own and other peoples’ current knowledge and competence to answer the question considered. Answerability judgments can also concern future answerability – whether the question can be answered today or in the future, and if in the future, how soon?

People can be overconfident that they already have the answer to a question, and this can sometimes have tragic consequences. For example, when pregnant women were prescribed Thalidomide, a medication against nausea that caused severe handicaps in their children, the question ‘Does this

¹ I use the American spelling judgment (instead of judgement) throughout the thesis in order to be consistent with the spelling in the published the articles.

medicine have serious side effects?’ was considered answerable (with the answer ‘no’) at the time (Westerholm, 2011).

On the other hand, people can erroneously dismiss or delay ingenious, innovative answers to questions because they are not yet accepted as reasonable options. For example, in the case of penicillin, it took several years from the initial discovery that a certain species of mould could kill bacteria to the widespread clinical use of antibiotics (Fleming, 1945). People may think that ideas or answers are too unlikely, difficult, or costly to develop and therefore give up prematurely. One important reason for these premature decisions to give up on finding an answer could be that the answerability of the question is judged to be too low.

Several practical areas could benefit from basic research into question answerability (e.g., medical and managerial decision making, climate science, and the psychology of innovation and acceptance of new technology). Research on answerability judgments can provide increased understanding of important social topics such as resistance to public vaccination, climate change denial, and why people may choose to believe in ‘alternative facts’ instead of scientific consensus. Many situations in which a person or organisation considers consulting others for help, advice, or answers are likely to include question answerability judgments as an important decision-making step.

Answerability judgments may also provide insights into people’s beliefs about the veridicality of information on the internet and on social media. ‘Fake news’ has been much discussed recently and false information can spread rapidly on social media. Therefore, it is of interest to investigate how people process not only answers, but also the answerability of ambiguous questions. The viral photograph of the blue and black (or white and gold) Dress, (Dressgate, 2016) is an example of how answerability judgments can become part of everyday judgments and decision making.

The Dress photograph (Figure 1), first posted on the internet in 2015, revealed stunning individual differences in colour perception (Lafer-Sousa et al., 2015) and beliefs about the correct colours. The pixels in the photograph, when analysed separately, were judged to be light blue and brown, but people perceived the Dress to be either blue and black or white and gold (Lafer-Sousa, et al., 2015). Theories about how these differences in perception of the colours arose include partly unconscious assumptions about lighting conditions when the photograph was taken (Gegenfurtner et al., 2015) and differences in cognitive processing in certain areas of the brain (Moccia et al., 2015; Schlaffke et al., 2015). The debate on social media concerned among others: What was the correct answer? Was there even a correct answer?



Figure 1. The Dress: blue and black or white and gold? The viral phenomenon ‘The Dress’ has its own Wikipedia site (Dressgate, 2016).

Research on answerability judgments is therefore also of interest in studying cognitive processing of ambiguous perceptual information. Colour judgments about the Dress photograph show the potential fraudulence of photographs as sources of information about reality. However, in professional and private life, people may often have to rely on mental representations elicited by photographs to make important decisions. A medical doctor may have an ambiguous X-ray picture to examine, an astronomer a fuzzy photograph of Mars, and a criminal investigator an ambiguous image of a suspect from a surveillance camera. In all these cases, photographs, which may or may not be reliable, could be the basis for judgments about reality. The increasing spread of cellphone cameras and public sharing of photographs contributes to these kinds of judgments becoming more and more common. What would the consequences be if an ambiguous photograph of a garment, like the Dress photograph, were evidence in order to identify a suspect? Research on the answerability of the question of the colours in the Dress may provide some indication of how people deal with ambiguous photographic information that is publically shared and discussed.

Basic research on answerability judgments may also be of interest for theoretical development in several areas of psychology related to memory, confidence, deception, future intentions, and decision making. This thesis is an early attempt to investigate how people judge answerability.

What is question answerability?

The idea that some questions are answerable and some are not is taken for granted in everyday life and in science. By answerable, I mean the question can be answered with a response that is correct, relevant (including being specific to an interesting level of granularity), and supported by good arguments. Answering ‘Over a year old’ would most likely not be considered an interesting answer to the question ‘How old is the oldest person still living?’ even though it would be correct. A more interesting answer would be ‘117 years’. In this context, there are thorny philosophical issues related to concepts of truth, knowledge, and uncertainty that have been debated for centuries by philosophers and some modern physicists. For example, people may disagree about the existence of a correct answer to a particular question or to questions in general. The main aim of this thesis is not to solve the issue of whether correct answers exist and people are able to articulate them. Instead, the aim is to measure people’s beliefs about the existence (or not) of correct answers to specific questions, since such judgments are important for other judgments and decisions.

Three questions arise when judging question answerability: (1) Do I know the answer myself (or not)? (2) Does someone else know the answer? (or not)? and (3) Can someone ever find out, and if so, who and when? When judging answerability, people may start by asking themselves ‘Do I know the answer?’ When they conclude that they cannot answer a question, they may wonder if someone else might know the answer, and if so who would be a good person to turn to. Thus, answerability judgments are relevant when people consider consulting others for the answer. Consultations about personal decisions can include medical counselling or asking a friend for advice; businesses and other organisations may hire professional consultants to advise them.

A question can be judged as more or less answerable based on how much effort it takes to answer it. A person may judge a question to be unanswerable, even in the future, because of the overwhelming complexity of the potential answer or a logical impossibility in the question itself, such as, ‘What is an example of a problem that will never be considered by any human being?’ (Rescher, 2009, p. 41).

The concept of an ‘answerable question’ has been used in the scientific literature. For example, ‘answerable clinical question’ is used in evidence-based practice (e.g., Elstein, 2004; Fineout-Overholt & Johnston, 2005; Houston & Kaatz, 2006; Sestini, 2010; Shaneyfelt et al., 2006), but to my knowledge there is no research investigating all three aspects of answerability judgments mentioned above (Do I know? Does someone else know? Can

somebody find out?). The four studies in this thesis are to my knowledge among the first to investigate judgments of question answerability in a broad sense.

Judging answerability: a creative process and a metacognitive judgment

To connect answerability judgments to previous research in psychology and to have a decent starting point for conducting research, it is important to classify what kind of judgment an answerability judgment is. The process leading to an answerability judgment can be classified in different, partially overlapping ways.

One perspective, following Busemeyer and Bruza (2012), considers answerability judgment, and human judgment in general, to be a creative process. Creative processes include both *divergent* tasks, aimed to generate as many original solutions to a problem as possible, and *convergent* tasks, aimed to identify one specific solution (Guilford, 1956). When facing a difficult question, generating as many original answer options as possible may be considered a divergent task. Selecting a preferred choice according to certain method may be considered a convergent task. Divergent and convergent processes have been associated with different types of brain activity (Jauk, Benedek, & Neubauer, 2012), so answerability judgments considered as creative processes are complex combinations of several different cognitive processes.

With new knowledge, beliefs about both the answer and the answerability of a question may alter with the changed *decision frame* of the question. The decision frame, as defined by Tversky and Kahneman (1981, 1985) includes the formulation of the problem and the contingencies associated with it. One important contingency could be what answer alternatives are known on the question topic. Adding a previously unknown option may change both the preferred answer and the answerability of the question.

In consumer research, it has been suggested that the relationship between available alternatives can influence a person towards making a *no-choice* decision because they are unwilling to choose between any of the available alternatives (Dhar, 1997). When a question is not considered answerable with scientific knowledge, one reason may be the relationship between the answer alternatives. Consider for example the question, 'Is there life anywhere in the universe other than on Earth?' Let us assume that a person believes this question is impossible to answer. Let us further assume that the same person hears the next day that a satellite has captured photographic evidence of

living micro-organisms on Mars. Faced with the new answer option, ‘Yes, micro-organisms have been spotted on Mars’, the person may change the answerability the question from ‘It is not possible to answer’ to ‘Yes, it is possible to answer, since life has been found on Mars’.

Answerability judgments could also, at least partly, be regarded as metacognitive judgments since they involve ‘one’s knowledge concerning one’s own cognitive processes or anything related to them’ (Flavell’s general definition of metacognition, 1976, p. 232). According to Flavell (1976, p. 907):

Metacognitive knowledge consists primarily of knowledge or beliefs about what factors or variables act and interact in what ways to affect the course and outcome of cognitive enterprises. There are three major categories of these factors or variables—person, task, and strategy.

These three metacognitive aspects are illustrated below. When the task is judging answerability, a person may consider who might know the answer to the question. For natural reasons people may start with themselves, asking ‘Do I know the answer?’ When faced with a question, a person may initially feel that they know the correct answer, even though they have not (yet) recalled or computed it. Reder and Ritter (1992) defined meta-knowledge as ‘how people determine what they know about a question before they actually answer it’ (Reder & Ritter, 1992, p. 435).

A person may also recall several possible answers and consider which one, if any, might be correct. Consider the question ‘Which flower is called *Anemone Nemorosa* in Latin?’ A person familiar with Latin flower names may be unsure whether the answer is wood anemone or blue anemone, but that person may believe that someone else, a biologist perhaps, would know the correct answer. This brings us to the second and third aspects of Flavell’s (1976) metacognitive knowledge: ‘Does someone else know? (Who knows?)’ and ‘Can someone find out?’ When considering whether someone else knows, people may think about who could be knowledgeable or how the knowledge could be acquired. A person could also consider whether answers provided by experts in the field are credible and certain (e.g., Anderegg, Prall, Harold, & Schneider, 2010; Broomell & Bodilly Kane, 2017). These considerations can also be regarded as metacognitive, since they include thoughts about the cognitions and knowledge of other people (Efklides & Misailidi, 2010; Flavell, 1976; Jost, Kruglanski, & Nelson, 1998).

Previous research

I have found no research focused precisely on answerability as defined above. However, much related research has investigated aspects of answerability judgments such as ‘Do I know (or not)?’, ‘Does somebody else know (or not)?’, and ‘Can someone find out (or not)?’ Much of such research has investigated questions with a consensus about an answer; this thesis contributes by including questions lacking a consensus about the correct answer.

Although no research describes answerability judgments exactly as defined above, several studies touched on the concept of answerability. Research in forensic psychology has studied participants’ ability to distinguish questions on ‘information not seen’ in a video clip (e.g., Buratti, MacLeod, & Allwood, 2014; Candel, Memon, & Al-Harazi, 2007; Frey & Scoboria, 2012; Roebers, von der Linden, Schneider, & Howie, 2007; Scoboria, Mazzoni, & Kirsch, 2008), which are considered unanswerable, from (answerable) questions about information shown in the video. The results suggest that it is generally difficult for people to separate what they have seen from what they have not and to distinguish between an answerable and an unanswerable question. Other research suggests there may be individual differences in making such judgments. Frey and Scoboria (2012) proposed that people may vary in their ability to separate what they have seen from what they have not seen, and denoted that ability *skill*. Frey and Scoboria (2012) also considered ‘I don’t know’ to be the correct answer when participants had not seen the information themselves.

When people say they do not know the answer to a question, this can mean several things, including that the question is not possible for them or anyone else to answer. ‘Don’t know’ judgments have been studied by several researchers (e.g., Glucksberg and McCloskey, 1981; Hampton, Aina, Andersson, Mirza, & Parmar, 2012; Kolers and Palef, 1976; Scoboria et al., 2008).

Glucksberg and McCloskey (1981) concluded that when people attempt to answer a question, they first search their memory to identify facts that may be relevant, and then further consider such facts (if found) in detail to assess whether they can be used to answer the question. Hampton et al. (2012) investigated whether people were consistent in their beliefs about ‘known unknowns’, things they were aware that they did not know. The results showed that people were consistently aware that they did not know some facts for sure, suggesting that they considered some questions less answerable, at least by themselves.

Another line of research concerns beliefs about certainty and uncertainty of knowledge (in particular domains or in general). Research on this topic has mainly been conducted in the field of educational psychology (e.g., Hofer and Pintrich, 2002; Scharrer, Britt, Stadler, & Bromme, 2013, 2014; Shtulman, 2013), but also in risk research (Bammer & Smithson, 2009; Kahan, Jenkins-Smith, & Braman, 2011) and in debated areas of knowledge such as climate science (Anderegg, Prall, Harold, & Schneider, 2010; Kahan, et al., 2012).

This line of research suggests there may be individual differences, as well as group differences in beliefs about the (un)certainty of knowledge. It also points to the importance of socially prevalent beliefs. For example, Kahan et al. (2011, 2012) suggest that people choose to believe the opinions of others with whom they share the same values, for example, members of the same political party. Furthermore, Shtulman (2013, p. 207) found that supernatural questions were treated the same as scientific questions in terms of their veridicality. Social consensus about a belief was clearly related to confidence that the answer was correct regardless of whether the belief was supernatural or scientific (Shtulman, 2013). People may also sometimes believe that scientific knowledge is limited and insufficient to provide quality answers to important questions concerning such things as nuclear risks (Sjöberg, 2001).

Factors related to question answerability

Many psychological factors can be related to, or influence, judgments of question answerability. Below I describe several factors focused on in this thesis. The aim is not to provide a complete list of all factors that might influence or be associated with answerability judgments, but to outline the ones most relevant to the four studies reported below: *socially prevalent knowledge*, *discussion with others*, *domain-specific contextual associations*, *previous experience*, *previous beliefs*, and *recent knowledge activation*. Some variables on individual difference were also investigated and will be described.

Social influence

Socially prevalent knowledge

In general, memories, cognition, and knowledge are distributed throughout a society and globally; no one can know everything, and humanity's understanding develops continuously (Atran, Medin & Ross, 2005; Perkins, 1993; Sloman & Rabb, 2016; Sparrow, Liu & Wegner, 2011). Therefore, people often need to rely on others' knowledge.

The 'wisdom of the crowd' phenomenon (e.g., Surowiecki, 2004) suggests it may be rational to consider answers from many different people, since the general tendency of these answers often turns out to be correct. However, the wisdom of the crowd assumes a suitable match between the crowd and the question. A large group of two-year olds may not on average estimate time correctly, for example. Collective or 'communal' ignorance (Faber, Manstetten, & Proops, 1992) may also mean that an incorrect consensus view sometimes becomes a 'misleading star' (Lorenz, Rauhut, Schweitzer & Helbing, 2010) as people put their faith into collective ideas even when they are incorrect (Asch, 1956; Koriat, 2008).

In everyday life, people collaborate in groups and meetings, in families and in business (e.g., people make decisions both as individuals and as members of groups). However, even when making decisions individually, memories and beliefs about what others may think can affect a person's memory and judgment (e.g., Fein, Goethals & Kugler, 2007; Gabbert, Memon & Allan, 2003; Hoffman, Granhag, Kwong See & Loftus, 2001). If, for example, a person's friends agree that a certain brand of camera is superior, a person may take that into consideration when wondering 'What camera is the best to purchase?' The perception that a question has been answered correctly implies (or is inferred to mean) that the question is answerable, so other people's (perceived) agreement on the answer to the question may be used as a cue when judging the answerability of a question. This is one way other people's opinions may be important in judgments about question answerability in everyday life. In Pre-study 1 (reported in Appendix C) we also examined people's beliefs about the consensus on whether the questions used in Studies I, II, and III were answerable.

Koriat (2012) showed that people are more confident in their answers when they agree with the majority. I will refer to this reliance on or adoption of the view of the perceived majority in a certain context as a 'consensus effect'. It should be noted that I use the word consensus in a broad sense to mean not necessarily an actual consensus, but what may be more important, a person's beliefs about what other people agree upon. The consensus effect

has also been described in research on conformity (e.g., Bond, & Smith, 1996; Hogg & Vaughan, 2014; Nolan, Wesley Schultz, Cialdini, Goldstein, & Griskevicius, 2008; van Cappellen, Cornelle, Cols & Saroglou, 2011).

If common views have a general (but fallible) tendency to be correct, the strategy of believing what others believe should help the individual save cognitive effort while still reaching a correct answer. Thus, people who believe there is an overall commonly held idea about the answerability of the question are likely adapt to that view. A person cannot consider every detail of every single issue or consider all potential risks. Therefore, if most people consider cellphones relatively risk-free, it makes sense to spend less time worrying about their potential hazards than if others show misgivings and fear about their use. If this reasoning is correct, the trend to follow the consensus may also be reflected in the individual's somewhat automatic memory processes when judging a question's answerability.

In some cases, it is important to note a person's beliefs about what *relevant* others think or about what constitutes a reliable consensus. People's beliefs about consensus and the groups they consider relevant to the question may vary (Kahan et al., 2011). The impact of a belief about the consensus may also be strengthened by the repetition of an answerability judgment by several different individuals. Repeated statements are often perceived to be truer, in what has been called the repetition effect or the truth effect (Dechêne, Stahl, Hansen, & Wänke, 2010). Dechêne et al. (2010) and Unkelbach, Bayer, Alves, Koch, and Stahl (2011) argued that one reason for the repetition effect is the metacognitive experience of ease, or processing fluency, while making a judgment with considerable corroboration. Processing fluency can be elicited by the ease of retrieving a correct answer. Because repeated items are more easily retrieved, relying on consensus can also be associated with fluency. The repetition effect is a robust phenomenon with respect to presentation, duration, and modality (Dechêne et al., 2010). Even a repeated finding of nothing can be convincing. For example, if a person is aware that many people have been unsuccessful in finding an answer to a question, they may decide that an answer simply does not exist (Hahn & Oaksford, 2007).

Because people's beliefs about consensus are likely to affect their answerability judgments, I compared consensus questions with non-consensus questions (in Studies I, II, and III). By consensus questions, I mean questions that most people believe relevant others agree are answerable by someone, if not themselves. Non-consensus questions are those for which there is no consensus among relevant others about answerability of the question. Under some circumstances it can be relevant to separate beliefs about consensus on the correct answer from consensus about the question's

answerability. For example, when considering the future answerability of a question, there may be consensus that the question will someday be answerable, while there is not yet a consensus about that answer will be.

Discussion with others

As answerability judgments depend on the processing of the answerability judgment task, such judgments may depend on whether the task is carried out alone or with other people. This was investigated in Study II. When comparing the conditions for information processing between individuals and pairs, two differences emerged as relevant. First, pairs were more likely to have more knowledge than individuals. Second, because they have more knowledge, when pairs collaborated on a judgment, they were likely to have more, and more diverse, memory cues than a single person making a judgment, simply because they have access to two minds instead of one. Pairs therefore seem to have access to a broader range of arguments than individuals. Since the pair members have to understand each other, one may also suspect that their communication may be more systematic and less intuitive than an individual's thinking (and think-aloud protocol) since individuals have only themselves to understand. (In Study II, individuals were asked to think aloud and this may have had the effect of making their thinking feel somewhat more social.)

However, although pairs and groups may statistically have access to more varied arguments, this may be limited by their tendency to discuss their shared knowledge more than their individual knowledge (Lu, Yuan, & McLeod, 2012). The focus on discussing common knowledge can lead to pairs judging questions with a high expected consensus as more answerable than individuals. A lack of common knowledge may also lead to pairs judging a question as less answerable. In general, pairs' answerability judgments may be more influenced by consensus effects than those of individuals, since discussion may make consensus (or lackthereof) more salient (e.g., Koriat, 2012; Koriat & Adiv, 2012). Thus, a group or a pair confronted with an answerability task has at least two types of consensus to consider: *present consensus* between group members and *referred consensus* – individual group members' beliefs about consensus among people not present (e.g., socially prevalent knowledge as described above).

It seems reasonable that when the present consensus and the referred consensus of significant other groups appear to fit an opinion may be more likely to be considered correct. For example, if friends, scientists, and co-workers all seem to agree that a question is answerable, the perceived truth of that statement may increase because it is repeated across groups.

Contextual associations

Domain-specific associations

Several researchers have suggested that individuals have preconceptions about knowledge in different domains (e.g., Stahl & Bromme, 2007). Stahl and Bromme (2007) suggested that these ‘domain-specific certainty beliefs’ act as a lens through which an individual makes judgments of knowledge (Bromme, Pieschl, & Stahl, 2010). Reder and Ritter (1992) suggested that the feeling of knowing an answer may be based on a shallow processing of the wording of the question. They argued that an initial feeling of knowing was based more on familiarity with the question items than with the answers.

In Study I, we speculated that many participants may have preconceptions (possibly derived from school education) that questions in computational domains such as geometry, measurement units, mechanics, or physics are always asked in a way that allows an answer to be calculated. We therefore believed that it might be possible to create a ‘feeling of others knowing’ (or others being able to compute) the answer, even when the computational question was manipulated to omit crucial information, thereby creating an illusion of answerability.

Recent knowledge activation

Previous research has shown that reflection upon one’s own knowledge before making confidence judgments can make people less confident that they know the correct answer (Allwood & Granhag, 1996). At the same time, people under some circumstances tend to be more confident in a friend’s overall knowledge than in their own (Johansson & Allwood, 2007). This prior research suggested it would be interesting to study whether answerability judgments are affected by recent knowledge activation (e.g., when reflecting about one’s own knowledge of the question). This question was explored in Study III.

Individual differences

People are likely to differ in their judgments on answerability, and it is therefore of interest to investigate the relation between individual differences and answerability judgments. According to Mohammed and Schwall (2009) individual differences matter most when questions are surrounded by

uncertainty, and they may therefore be of special interest for questions with no consensus about answerability. The concept of individual difference is used here in a broad sense and includes, among other factors, optimism and general beliefs about knowledge and knowing. The term ‘individual difference’ may or may not be an apt choice to describe such variation, however, since optimism and beliefs may alter over time with new experiences, previous beliefs, and education. However, the main purpose was not to describe and search for individual traits, but to investigate individual variation that is stable enough over time to affect other judgments.

A common opinion, supported by much research, holds that previous cognitions act as a base for subsequent judgments (see e.g., Busemeyer & Bruza, 2012). Moreover, people often act to preserve their previous opinions by interpreting information in a way that confirms their personal view, resulting in *confirmation bias*, (e.g., Nickerson & Raymond, 1998). For example, a person who believes a drug has no side effects will be more willing to believe studies reporting there are no side effects (Hahn & Oaksford, 2007), while another, who suspects side effects and reads the same studies showing no side effects, may conclude that the question is not answerable, since there may be side effects that the studies do not show. Because such beliefs can change with new experiences or for other reasons, they may not be considered traits, but may still be stable enough over time to influence answerability judgments (e.g., a person who does not believe in side effects may change that belief after experiencing them.).

Cognitions can generally be more abstract or more concrete, and this may be relevant in judgments about answerability. For instance, people can have abstract beliefs about the side effects of drugs in general and concrete beliefs about the specific side effect(s) of a particular drug. Specific, concrete beliefs based on experiences may affect more abstract general beliefs. For example, experiencing the side effects of one drug can affect the general belief that certain kinds of drugs have side effects. More general beliefs can also colour judgments on specific topics. Schuman and Presser (1996) demonstrated that a general belief affected judgments on a question when participants were undecided and had no opinion on the specific topic. When Americans were asked whether Russian and Arab leaders were working for peace and compelled to give an opinion other than their preferred ‘I do not know’, their judgments were affected by their general beliefs about world leaders working for peace. It is also possible, especially when individuals have no previous strong opinions about a question, that their general beliefs can be applied to their judgment of whether a specific question is answerable.

Epistemic measures

Belief in certainty of knowledge

General beliefs about certainty in knowledge may be especially important for judging question answerability. Such beliefs have been researched in educational psychology (e.g., DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008; Kardash & Scholes, 1996). The term *epistemic beliefs* refers to personal beliefs about knowledge and knowing (Schommer, 1990).

One dimension of epistemic beliefs relevant to question answerability is the belief in ‘certain knowledge’, which has been addressed by many researchers (e.g., Bråten & Strømsø, 2005; Clarebout, Elen, Luyten, & Bamps, 2001; Schraw, Bendixen, & Dunkle, 2002). In this literature it is assumed that development goes from a black-and-white perspective in childhood, when knowledge is seen as certain and distributed by an authority, to a more relative view in which certain answers may be out of human reach (Elby & Hammer, 2000; Perry, 1970). In this literature, *global certainty beliefs* are separated from *domain-specific certainty beliefs* (e.g., Khine, 2008). Global certainty beliefs concern knowledge in general, while domain-specific beliefs refer to beliefs about certainty of knowledge in a particular discipline. Henceforth when referring to certainty beliefs I mean global certainty beliefs.

Kuhn, Cheney, and Weinstock (2000) found in their research with children that *epistemological understanding* is something that develops over time. ‘Initially, the objective dimension of knowledge may dominate to the exclusion of subjectivity; subsequently, the subjective dimension dominates and the objective is abandoned, and, finally, the two are coordinated’. Kuhn et al. (2000) suggested that these phases apply to any cognitive development in any domain, but are also global properties of cognitive development. It is reasonable to assume that a person with a strong belief in certainty of knowledge would be more prone to believe that questions have answers. In line with Schuman and Presser’s (1996) example showing how general beliefs affect specific questions, it is possible that the effect of these beliefs will be heightened on issues where no previous strong opinion has been formed.

Trautwein and Lüdtke (2007) investigated whether beliefs in certainty of knowledge could predict the perceived certainty of different theories (e.g., the ‘big bang’ theory) but found only weak correlations between general beliefs in certainty of knowledge and beliefs about certainty in these theories. However, the weakness in those correlations may partly originate in the fact that participants already had formed strong opinions on the topics. Most of

the theories used as stimuli material were rated high in familiarity by the participants. Using regression analysis, Trautwein and Lüdtke (2007) found that familiarity increased the certainty belief in the theory. I describe more theories about how familiarity may affect answerability under the heading ‘Previous experience’ below.

Mankind’s knowledge

Another epistemological issue that may affect question answerability is belief(s) about the limitations and usefulness of *mankind’s knowledge*. Sjöberg suggested for example that ‘people believe that there are clear limits to what science and experts know’ (2001, p. 189). Munro (2010) also showed that personal beliefs that diverge from scientific consensus can make people doubt whether a question is scientifically answerable. Since we knew of no available measure of beliefs about mankind’s knowledge, we developed items in Study II for that purpose.

Mankind’s efficacy

Another kind of individual epistemological belief is about *mankind’s efficacy*, that is, our ability to reach epistemic goals (e.g., answering a question). It is reasonable to expect that high ratings of mankind’s knowledge and ’s efficacy will be associated with higher answerability ratings. As with mankind’s knowledge, no validated measure was available for mankind’s efficacy, so we created a measure for Study I by paraphrasing items from the self-efficacy scale (Löve, Moore, & Hensing, 2012).

Maximisation Tendency

Maximising is a decision-making style used to find and select the very best alternative rather than one that is ‘good enough’. Maximisers tend to be willing to spend great effort to find the optimal solution to a problem (Schwartz et al., 2002). However, not every problem or question can be given maximum resources. Consequently, maximisers may feel that their own reasoning would be insufficient for some questions and they may therefore choose to rely on other people who have spent more time considering the issue. In terms of answerability, this would mean that maximisers would tend to more than others to believe that someone other than themselves knows the answer. This is in line with findings reported by Parker, Bruine de Bruin, and

Fischhoff (2007), which showed that maximisers tend to avoid decision making and to depend on others.

Epistemic preference

People may also have different epistemic styles. Some people may be more inclined to voluntarily reflect on philosophical issues, while others may have a more pragmatic style. The measure EPI-r was developed to investigate epistemic style (Elphinstone, Farrugia, Critchley, & Eigenberger, 2014). There are two kinds of epistemic preferences measured on the EPI-r. The first is deeper intellectual processing measured on EPI-r Intellectual scale (e.g., ‘In the simplest terms, I have a strong need to study just how and why things happen’), and the second is more automatic default processing measured on the EPI-r Default scale (e.g., ‘When confronting the deep philosophical issues of life, I am more inclined to just deal with it, get the job done, and move on’). We expected that participants with a preference for intellectual processing would have lower answerability judgments than those who scored higher on the Default scale since we thought intellectualisers would problematise the questions more. We also expected that participants with default processing preferences would choose the easiest answerable interpretation and would therefore find more questions answerable, since unanswerable questions could be considered too demanding to spend time thinking about.

Need for cognition

The need for cognition is a cognitive style that may be associated with answerability judgments. People with a high need for cognition enjoy difficult and effortful cognitive tasks (Cacioppo, Petty, & Kao, 1984). Need for cognition is also associated with fluid intelligence, which can be considered an important asset in creative thinking (Fleischhauser et al., 2010). When faced with a difficult question, people with a high need for cognition may elaborate it more thoroughly and in ways people with a low need for cognition would not. Because they may elaborate difficult questions, people with a higher need for cognition may also be more able to identify uncertainties and more accepting of the alternative that some questions are not possible to answer.

Optimism

Finally, optimism may also affect answerability judgments. People with generalised optimism tend to interpret things positively and are less likely to give up (Carver, Scheier, Miller, & Fulford, 2009; Muhonen & Torkelson, 2005). It is therefore likely that optimists are more prone to believe that answers exist and can be found if the search for them continues. On the other hand, optimists expect good things to happen in uncertain times (Monzani, Steca, & Greco, 2014) and this could lead to their better tolerance of uncertainty. Optimists may therefore be more comfortable with uncertainty and more willing to accept that answers to questions may be uncertain or non-existent. Optimism is an interesting phenomenon and different features of it seem theoretically related to answerability in different ways; therefore, optimism is worth further research in relation to question answerability, even if (or perhaps especially because) it is not evident what results may emerge.

Previous experience and previous beliefs

People may also differ in their previous beliefs about the specific question, and previous experience of the question or the topic is also likely to affect their answerability judgments. Previous experience of a question is associated with more familiarity, which may create a feeling of knowing the answer (Reder & Ritter 1992). Furthermore, familiar theories, such as familiar answers to difficult questions, are considered more certain than less familiar ideas (Trautwein & Lüdtke, 2007). In Study IV, we investigated the effect of previous experience of an ambiguous colour judgment, assuming that familiarity would lead to a higher belief that there is a correct answer and that less experience would be associated with the belief that the question is not answerable.

Measuring answerability

Because answerability judgments may be multi-faceted, different ways have been used to ask about answerability.

In Studies I and II, the answerability of questions *today* was investigated on a *current answerability scale* (Figure 2). In these studies, answerability was presented as a matter of degree and measured on a percentage scale. In Study I, answerability today was compared with beliefs about when an

answer might be found *in the future*, measured on a *future answerability scale*, also called *the future scale* (Figure 2). The future scale, the belief that a question is *unanswerable*, that it will never be answerable, was also an option. In Study II, the *current answerability scale* from Study I was also used. In Study III, we designed an *option-scale* (Option Scale 1) to separate beliefs about who knew the answers. As shown in Figure 2, this scale included ‘I know’, ‘Somebody else knows’, and ‘Nobody knows’ options. In Study IV, answerability was measured for a question about a photograph widely circulated on the internet, which prompted debate about the correct colour of ‘The Dress’. In Studies I, II, and III, instructions explained the concept of answerability to the participants. In Study IV, a popular wording for low answerability, ‘There is no correct answer’, was used in another option scale (Option Scale 2).

Current answerability scale used in Studies I and II

Cannot be answered correctly by a now living person (0%)	0 10 20 30 40 50 60 70 80 90	Can be answered correctly by a now living person (100%)
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Future answerability scale used in Study I

Can be answered today by me (and maybe someone else)	Can be answered today by someone else (but not by me)	Can be answered within one year	Can be answered within 10 years	Can be answered within 20 years	Can be answered within 50 years	Can be answered within 100 years	Can be answered within 200 years	Can be answered after 200 years	Can never be answered
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Option scale 1 used in Study III

- A. I know, the answer is _____
- B. Someone else knows.
- C. Nobody knows.

Option scale 2 used in Study IV

- Blue and black
 - White and gold
 - Others, namely _____
 - There is no correct answer.
-

Figure 2. The answerability scales used in Studies I, II, III, and IV.

Aim

The overall aim of this thesis was to explore, understand and highlight different aspects of question answerability judgments.

The four studies in this thesis deal with five main questions:

1. How can different forms of answerability judgment be measured?
2. Are some types of questions perceived to be more answerable than others?
3. How are question answerability judgments affected by social influence?
4. How are different contextual associations associated to answerability judgments?
5. Are individual differences related to question answerability judgments?

Summary of empirical studies

Introduction

The four empirical studies (Studies I -IV) in this thesis investigated question answerability from different perspectives by varying and measuring different factors that may be related to judgments about answerability: *Social influence*, *Contextual differences*, and *Individual differences*.

There were five research questions. The first, *How can different forms of answerability judgments be measured?* was investigated in all studies. The second, *Are some types of questions perceived to be more answerable than others?* was investigated in Studies I, II, and III. The third, *How are question answerability judgments affected by social influence?* and fourth, *How are different contextual associations associated to answerability judgments?* were explored all studies. Finally, *Are individual differences related to question answerability judgments?* was explored in Studies I, III, and IV. In addition to these main questions, we also explored the possibility of creating ‘a feeling of others knowing’ in Study I.

In the studies, we used different formats of the answerability question. In Studies I and II we explored judged current answerability on a percent scale. Current answerability, that is if the question is answerable today, was compared to answerability in the future in Study I. In Study III we provided ‘I know’ and ‘someone else knows’ from ‘nobody knows’. In Study IV we suggested alternatives, including the answer ‘There is no correct answer’.

General method

In Studies I, II, and III questions with an expected high consensus concerning their answer were called *consensus* questions (e.g., What is the name of our galaxy?). The answerability judgments of these questions were compared to questions with low expected consensus about an answer (henceforth called *non-consensus* questions; for example: How many galaxies are there in the universe?). Study IV focused on one question, a non-consensus question. In Study I, an additional question category was used. This question category was denoted *illusion* questions (e.g., How large is the area of an ellipse, with

a minor axis of 2 cm?²). In this category, crucial information needed to compute the answer to the question was absent. For an overview of the studies, see Table 1.

General material

Answerability questionnaires

In Studies I, II, and III we defined and instructed participants that by an answerable question we meant one that has a relevant, correct, and reasonably precise and complete answer, and for which strong and reasonable arguments can be made to support that answer.

First, we created a battery of 50 generic questions. Question items were created by the researchers or selected from a large sample of generated questions. This resulted in a battery of 26 consensus, 20 non-consensus, and 4 illusion questions (see Appendix A). These questions were explored and validated in two pre-studies (the pre-studies are reported in Appendix C). A subset of the original 50 questions was used in Study I. A subset of the questions (and some new questions) was used in Study II. All 46 of the consensus and non-consensus questions from the original 50 were used in Study III.

In Study IV, participants could freely interpret the meaning of the alternative ‘There is no correct answer’, but the researchers interpreted that alternative to mean that the participant did not believe the question was answerable.

² To compute the area of an ellipse you also need information about the major axis.

Table 1. Overview of empirical Studies I, II, III, and IV

Study (N)	Type of question	Individual difference measures	Scale	Method	Design
I (476)	General knowledge questions: 8 consensus 2 illusion 12 non-consensus	Certainty Beliefs (2 items) Epistemic Preference Mankind's efficacy Optimism Mankind's knowledge	Current (percent), Future (time)	Web survey	Study I. Two order conditions: Certainty beliefs first or Certainty beliefs last.
II (91)	General knowledge questions: 4 consensus 16 non-consensus		Current (percent)	Paper and pen questionnaire Think aloud, Pair discussion	Two groups: Questions answered individually (Think aloud) or in pairs (Group discussion)
III (123)	General knowledge questions: 26 consensus 20 non-consensus	Certainty Beliefs (4 items) Maximization tendencies Need for cognition	Options (option scale 2)	Paper and pen questionnaire	Two groups: Randomised to knowledge ratings before judging answerability and control condition
IV (186)	Colour question: 1 non-consensus, 	Optimism (Lot-r)	Options (option scale 1)	Web survey	Two groups: seen or not seen The Dress before

Study I

Purpose

The two most important purposes of Study I was to compare consensus and non-consensus questions on answerability *today* and in *the future*. We also wanted to investigate how individual differences were related to the answerability judgments. In addition, we openly explored if an “illusion of answerability” could be created.

Method

Study I was performed by means of a web survey with 476 participants from research pools at the University of Gothenburg. The participants were asked to judge the answerability of 22 questions (8 consensus, 12 non-consensus, and 2 illusion). Approximately half of the participants were randomised to judge if the questions were answerable by anyone *today* using a *current answerability scale* variant. The other half of the participants was randomised to judging answerability *in the future* on *the future answerability scale* variant (Figure 2 shows the two scales). All participants judged questions on certainty beliefs, mankind’s efficacy, mankind’s knowledge (Items are shown in Appendix B), optimism (Lot-r) and epistemic preference (Epi-r).

Within each scale variant the order of the question blocks was varied, constituting two order conditions. In the *first order condition* participants rated certainty beliefs first, thereafter, answerability questions and finally the other measures in randomised order. In the *second order condition* participants rated the answerability questions first, then the other measures in randomised order and finally epistemic beliefs.

Hypotheses and questions

Hypothesis (1). Consensus questions would be rated higher in answerability than non-consensus questions.

Hypothesis (2-6). We believed individual differences would matter more for non-consensus questions. We expected the higher scores on measures concerning epistemic issues (i.e. certainty beliefs, epistemic default processing, mankind’s efficacy and mankind’s knowledge) to be positively related to higher answerability judgment scores.

Explorative questions: The potential relationship between optimism and answerability was explored. Also the relation between answerability today

and answerability in the future was explored, by comparing the two scale variants. In addition, answerability ratings of the illusion questions were openly explored.

Results

Our first hypothesis was confirmed. Consensus questions were judged more answerable than non-consensus questions.

Current answerability: We did not find any significant differences, in current answerability between the participants rating beliefs in certainty of knowledge first or last. Therefore, these results were analysed on an aggregated basis for the current answerability scale. The hypothesis about individual differences and answerability was partly confirmed. Mankind's efficacy and certainty of knowledge were correlated with higher current answerability. Optimism was correlated to higher usage of "*cannot be answered today*" on the *current answerability* scale variant for non-consensus questions

Future answerability: When judging *future answerability*, the results for the non-consensus questions differed slightly depending on whether certainty beliefs were rated before or after the judgment. The participants who rated certainty beliefs before rating the non-consensus questions on the future answerability scale rated these questions to be possible to answer in a more distant future than the participants who rated epistemic beliefs items after their answerability judgments. Therefore the future answerability judgments in Study I were analysed on both aggregated level (all question types together) and in addition, the non-consensus questions were analysed separately for the two order conditions.

On an aggregated level, for all question types and order conditions, individuals scoring high on the scales belief in certainty of knowledge, mankind's efficacy, and mankind's knowledge used the alternative "*can never be answered*" less frequently. Higher scores on mankind's knowledge and mankind's efficacy were correlated to rating the non-consensus questions more answerable in the near future. When belief in certainty of knowledge was rated before future answerability, the correlation between future answerability and the variables mankind's efficacy and mankind's knowledge was stronger.

The *future answerability* ratings were highly correlated with *current answerability ratings*. Thus, questions that were rated to be less answerable today were rated to be answered in a more distant future (or never to be possible to answer). Illusion questions were rated quite high in answerability, but had a larger standard deviation than consensus questions. Rating the

illusion questions as more answerable in the future was correlated to higher ratings of mankind's knowledge and lower ratings of EPI-intellectual style. There were no correlations between the individual difference measures and the consensus questions.

Study II

Purpose

The purpose of this study was to compare the answerability judgments of individuals and pairs for consensus and non-consensus questions (questions with high and low expected consensus with respect to their answer).

Method

In total, 91 participants from a student research pool took part in the study. Thirty-one participants made individual judgments of the answerability of twenty questions (16 non-consensus and 4 consensus; see Appendix A) while thinking aloud and 60 participants made their judgments in pair discussions. The questions were answered on the current answerability scale used in Study I (Figure 2). Think-aloud protocols and pair discussions were recorded and transcribed.

Hypotheses and questions

Two hypotheses and one question were formulated. (1) Both pairs and individuals were expected to give higher answerability judgments of the consensus questions than for the non-consensus questions. (2) Pairs, compared to the individuals, were expected to rate consensus questions more answerable and non-consensus questions less answerable. In addition, an exploratory question was posed: Is the number of words spoken related to perceived answerability?

Results

The three hypotheses were confirmed or partly confirmed. Consensus questions were rated higher on answerability than non-consensus questions by both pairs and individuals; pairs gave higher answerability ratings for consensus questions and lower ratings for non-consensus questions than

individuals; and on the explorative question, no significant correlation was found between the number of words spoken and the answerability judgments. However, the pairs who spent more words on consensus questions also rated them comparatively lower on answerability. When comparing the relative number of words for the consensus questions and the non-consensus questions both pairs and individuals spent much more words on the non-consensus questions. This discrepancy was more evident for the pairs. The difference between individuals and pairs with respect to relative number of words spent on each question category was statistically significant.

Study III

Purpose

The purpose of Study III was to investigate the difference between beliefs that “I know”, “someone else knows” or “no one knows” in relation to different question types (consensus and non-consensus), recent knowledge activation and individual differences in certainty beliefs, need for cognition and maximisation tendencies.

Method

In total, 123 participants from a student research pool took part in the study. They judged the answerability of 26 non-consensus and 20 consensus questions (see Appendix A). When judging answerability, participants could choose between ‘I know’, ‘someone else knows’, or ‘no one knows’. The judgments were performed individually on a written questionnaire.

Half of the participants rated the extent of their knowledge about the question before making each answerability judgment. An example of a knowledge rating is *How much relevant knowledge do you have to answer the question ‘Where is the main office of NASDAQ?’*. Participants rated their knowledge on an 11-point scale ranging from 0 (“I have no relevant knowledge”) to 100 (“I have all relevant knowledge”), with 10-points increments (10, 20, 30, etc.). After making the knowledge rating participants in the knowledge rating condition judged the question on answerability, for the corresponding question: *Where is the main office of NASDAQ situated?* (‘I know’, ‘someone else knows’, or ‘nobody knows’). Participants in the control condition only made answerability judgments. Last, self-report measures of need for cognition (Cacioppo et al., 1984), maximisation

tendencies (Diab, Gillespie, & Highhouse, 2008) and belief in certainty of knowledge (see Appendix A) were rated.

Hypotheses and questions

Five hypotheses were formulated. The first (1) concerned the experimental condition (knowledge rating before answerability judgment or control); the second (2), the type of question (consensus or non-consensus), and the others concerned individual differences in (3) beliefs in certainty of knowledge, (4) maximising tendencies, and (5) the need for cognition. (These hypotheses are more fully explained below.)

Results

Most of hypotheses (1, 2, 4 and 5) were partly confirmed one (3) was completely confirmed.

Hypothesis 1 regarding knowledge rating condition was partly confirmed. Participants in the knowledge rating condition had a smaller proportion of ‘no one knows’, but no interaction between condition and question type was found.

Hypothesis 2 concerning type of question was confirmed in its main assumption. The likelihood of answering ‘no one knows’ was higher for the non-consensus questions than the consensus question, showing a main effect for question type. However, our additional assumption that there were no compelling reasons to find a difference in the likelihood between choosing ‘I know’ and ‘someone else knows’ for the different question types was not supported since the likelihood of choosing ‘someone else knows’ was higher than choosing ‘I know’ for non-consensus question compared to the consensus questions,

Hypothesis (3) concerning certainty in knowledge was confirmed, since people with higher certainty beliefs were less likely to say, ‘no one knows’. Also, as predicted, an interaction effect between certainty of knowledge and question type was found. The likelihood of answering “*someone else knows*” was higher compared to “*I know*” and “*no one knows*” for participants with high belief in certainty of knowledge when answering non-consensus questions.

Hypothesis (4) The fourth hypothesis stated that people high in maximisation would choose “Someone else knows” more often than the two other options for the non-consensus questions. This hypothesis was confirmed since the analysis did show an interaction effect between maximisation and question type, the log odds of choosing “*someone else*

knows” were higher for people high in maximisation when answering non-consensus questions.

Hypothesis (5) concerning need for cognition was partly confirmed. No interaction effect was found between question type and need for cognition as we expected. However, we found a main effect of need for cognition in the way that people high in need for cognition were less likely to believe “*someone else knows*” compared to “*I know*” or “*no one knows*” for both non-consensus and consensus questions.

Study IV

Purpose

The main purpose of this study was to investigate whether laypersons believed that the question about the correct colour of The Dress (Figure 1) was answerable. An additional purpose was to investigate the effect of previous experience and personal optimism on this answerability judgment. The question about the correct answer to The Dress’ colours, could be regarded as a non-consensus question, since people disagreed about what they saw and believed was correct and was therefore interesting from an answerability point of view.

Method

A total of 190 people from a participant pool at University of Gothenburg, answered a web survey. While viewing The Dress photograph, they were asked whether they had seen the photograph before, and what colours they perceived (‘blue and black’; ‘white and gold’; ‘others, namely...’). Then there was a page break and participants were asked what they believed was the correct colours of The Dress (‘blue and black’; ‘white and gold’; ‘others, namely...’; or ‘there is no correct answer’). It was not possible to go back to previous pages.

Hypotheses and questions

Two hypotheses were formulated:

- (1) Participants who had seen The Dress before would be less likely to choose ‘there is no correct answer’.

- (2) Optimists would be more likely than others to believe 'there is no correct answer' to the question about The Dress colour, in line with Study I.

Results

The two hypotheses were confirmed. Participants who had seen The Dress before chose 'there is no correct answer' less often than those who had not. Participants who scored higher on optimism chose 'there is no correct answer' more often than those who scored lower.

General discussion

This thesis investigated answerability judgments, that is, the judgment if anyone can provide a correct answer to a specific question. The results suggest that a person's belief about answerability of a specific question can be affected by socially prevalent knowledge and the social and individual memory context where the question is presented. When consensus about answerability is low, several individual differences (e.g., certainty beliefs, optimism and need for cognition) were related to answerability judgments. When applying answerability judgments of general knowledge questions to an ambiguous colour judgment, it was noticed that some people do think there is a correct answer about colours, and some people not believe in the colours they perceive.

First I will discuss why some questions were perceived to be more answerable than others. Second, I will describe the findings about question answerability judgments regarding social influence, including when discussing with others compared to performing the judgments individually. Third, the findings regarding individual differences in relation to question answerability will be dealt with. Fourth, the possible impact of recent knowledge activation will be discussed. Finally, theoretical implications, practical implications and limitations are discussed and suggestions for future research are provided.

Are some types of questions more answerable than others?

One of the research questions of this thesis was *Are some types of questions perceived to be more answerable than others?* In Studies I, II, and III questions with high expected consensus about the answerability (consensus questions) were compared to questions with low expected consensus (non-consensus questions). In Study I, a question category called illusion questions was also included. Illusion questions may have appeared answerable, but lacked the necessary information to allow a precise and interesting answer. Consensus questions were perceived most answerable, illusion questions second most answerable, and non-consensus questions the

least answerable. This was in line with expectations. Furthermore, in Study IV, we included a question regarding a visual judgment.

Consensus questions

The participants rated consensus questions more answerable today (Study I and Study II) and in the future (Study I). This result fits expectations about effects of (perceived) consensus, including Koriat's self-consistency model (2012) where people are more confident in answers with an expected collective agreement. Since consensus opinions are more likely to be repeated, it is also in line with a general truth effect (Dechêne et al., 2010) that repeated statements are considered as more likely to be true. In addition, the result from the future answerability scale variant showed that many participants thought they knew the answer themselves to the consensus questions which may also increase confidence that the question is answerable.

Illusion questions

The illusion questions were rated second most answerable in Study I. Many respondents thought somebody else would be able to answer the question today, suggesting a "feeling of others knowing" was created. Since it is unlikely somebody could come up with an answer to these questions, the results indicated that these questions created an illusion of others knowing. The standard deviation of the illusion questions was large, indicating that other factors than consensus may also be relevant for answerability judgments like different kinds of processing (more superficial or more deliberate processing) or individual differences. Individual differences will be discussed below. Participants that regarded the illusion questions as answerable on the future answerability scale also preferred epistemic default processing as measured by Epi-r (Elphinstone et al., 2014). This could indicate that the illusion of answerability may have been created because people processed the illusion questions on a shallower level, for example based on preconceptions, possibly derived from school, that computational questions in that domain are answerable (Stahl & Bromme, 2007).

Non-consensus questions

The non-consensus questions were perceived to be the least answerable type of questions today (Study I, and II) and in the future (Study I). The standard deviation of the non-consensus questions was large and this indicated that

other factors than consensus, e.g., individual differences and different kinds of processing may also play an important role when judging their answerability. This is also in line with Mohammed and Schwall's (2009) general finding that individual differences matter more for judgment and decision making under uncertain conditions. Such factors are further discussed below.

Social influence

Socially prevalent knowledge

The results from the Study I, II and III, indicate that beliefs about socially prevalent knowledge is important for answerability judgments. Questions that were judged to have higher consensus about answerability was judged to be more answerable. These results suggest that people agree with other persons' judgments of answerability, when judging answerability of questions. I have earlier referred to this as the effect of consensus or socially prevalent knowledge.

Within research on social influence, compliance is used to denote the response to a specific request, for example providing an answer to a question. Conformity is used when describing people's attempts to match their behaviour to that of others, for instance changing your own opinion when learning about other people's opinions (Cialdini & Goldstein, 2004). Deutsch and Gerard (1955) further distinguished between two types of conformity responses; *normative conformity* is when people follow others to gain social approval, while *informational conformity* is when people use other people's behaviour as guidelines to seek information about reality. Regarding question answerability people can of course answer in line with the majority with the goal of gaining social approval, but also because they believe that the majority may be correct. People may believe that socially prevalent knowledge is likely to be correct for at least three reasons:

First, according to the wisdom of the crowd phenomenon the *central opinion may often be the correct answer* (e.g, Surowiecki, 2004) even though there are exceptions where social influence can undermine the wisdom of the crowd phenomenon (Lorenz et al., 2010). Second, the consensus opinion is likely to be repeated and what is *repeated* is often *believed to be truer* (e.g., Dechêne et al., 2010) and to be judged as truer. Thirdly, socially prevalent knowledge may also increase the likelihood that there is a short *experienced psychological distance* (Trope & Liberman, 2010) to a person claiming to

know an answer to a person claiming that the question is answerable, and possibly also providing an answer. If there is a wide-spread consensus that the question is answerable, and possibly also what the correct answer is, it is likely that a person will know someone within close psychological distance who would claim the question is answerable.

Discussing with others

The presences of another person when deliberating about answerability of questions seem to interfere with the result. The results in Study II showed that pairs rated the consensus questions more answerable, and the non-consensus questions less answerable, than individuals. This result was in line with a consensus effect and a polarisation effect. Thus, it seems like consensus arguments may have been more salient for pairs' judgments of answerability than for individuals'. The difference in consensus dependence between individuals and pairs has similarities with research on conformity such as Asch's (1956) findings where participants agreed with consensus about the length of a line when in the group, but often answered differently when interviewed individually afterwards. People may conform to others for various reasons, such as a belief that others often know more than oneself about reality, or because they want to avoid social disapproval from other people present. Moreover, sometimes people conform to the norm of a group they identify with, regardless if other people from the group are present (Hogg & Vaughan, 2014).

The consensus effect may be increased in pairs since pairs can take into consideration both present consensus (among pair members) and referred consensus (beliefs about consensus of groups not present). If all consensus coincide, the belief that the question is answerable might be amplified. However, if the different forms of consensus are in conflict the opposite may occur. It is also possible that the pair condition had a more deliberate processing since assumptions taken for granted may be questioned or sensitised when discussing with others (the pair member). This could have resulted in a "deeper" processing of possible complexities and uncertainties, which may have made participants realise that it is difficult to judge if the question considered can be answered and thus to have contributed to lower answerability judgments. More deliberate processing can also be elicited as a consequence of special types of accountability. Sometimes when discussing answerability, participants strongly defended their own standpoints and generated critical reasons and arguments why they were right and the other person was wrong (Study II). This could be explained in terms of post-

decisional accountability, that is, that the individual was trying to defend his/her own previous judgment (Lerner & Tetlock, 1999). When discussing non-consensus questions, compared to consensus questions, it is also more likely that the pair members did not on beforehand know other person's view (Study II). When, decision-makers knows in advance that they will be accountable to an audience with unknown views who is interested in accuracy they are more likely to use self-critical and effortful thinking (Lerner & Tetlock, 1999).

Recent knowledge activation

According to Stewart, Chater, and Brown (2006), and other researchers, people's judgments are often constructive and affected by sample items from both the immediate context and the person's memory. The results from Study III suggest that participants who rated their own knowledge before performing answerability judgments had a smaller proportion of 'No one knows'.

By activating memory representations in the knowledge area when doing knowledge ratings, participants may have been more aware of the possibility that the question answerability rated can be answered (Reder, 1987; Reder & Ritter, 1992). Speculatively, the activation of the participants' knowledge in memory created by the knowledge ratings may have created a feeling of familiarity that influenced the participants when they made their answerability judgments.

A combination of more "somebody else knows" and "I know" would lead to a decrease in "nobody knows". Below I speculate about reasons how knowledge ratings could increase "somebody knows" and "I know".

According to Chen and He (2017) contrast effects can be found in judgment and decision making, when judging temporal distance and probability. Participants who memorised long-term and low-probability events treated certain delays as more proximal than those memorising short-term and high-probability events. It is possible that the effect of knowledge ratings could referred to a contrast effect, where other people's knowledge seems better than one's own knowledge on the topic. Consequently, they would more often choose 'somebody else knows'.

The knowledge ratings could also have activated memory cues that helped the participants to recall answers they believed were true, which led them to choose 'I know'. For example, they may have mentally reinstated the physical and psychological environment of the original events when they learned the answer to the question. This technique is shown to be memory

enhancing technique (see Williams & Holland, 1981) and is for example used in the so-called cognitive interview when interviewing eyewitnesses (Fisher Geiselman, Raymond, Jurkevich & Warhaftig, 1987).

Individual differences in judging answerability

Individual differences turned out to be related to the level of the answerability judgments. Individual differences were as suggested by Mohammed and Schwall (2009) more important when the questions were surrounded by uncertainty.

Epistemic measures

Three of the epistemic measures (i.e., mankind's efficacy, mankind's knowledge and certainty beliefs) were correlated with each other in Study I. These measures were also correlated with lower numbers of "can never be answered" responses, suggesting the view that for many questions knowledge is experienced to be just a matter of time and not beyond reach of human capacity. Thus, there may be some support for individual variation in the disposition to think that humans, in general, can gain knowledge (henceforth called the 'human knowledge disposition'). By a human knowledge disposition, I mean that people often believe that answers exist to non-consensus as well as consensus questions.

This tendency, if it has some stability, may be important when facing new challenges. For example, a construction project leader needs to judge quickly which challenging questions are answerable, and how quickly, to adhere to the set budget. Project leaders with a strong human knowledge disposition will be more likely to consult experts since they assume an answer, even if yet unfound, is known to someone.

Maximisation tendencies

In Study III, the fourth hypothesis stated that people high in maximisation would choose "Someone else knows" more often than the two other options for the non-consensus questions. This hypothesis was confirmed since the analysis did show an interaction effect between maximisation and question type.

In Study III, higher maximisation tendencies was associated with the belief that someone else could answer the question. Maximisers may think

that an optimal solution exists to their decision problem (Schwartz et al., 2002), but may have an avoidant, dependent decision-making style (Parker, Bruine de Bruin, & Fischhoff, 2007). Choosing ‘someone else knows’ could be considered a way to avoid taking a personal standpoint. The results from Study III, were in line with these expectations.

Need for cognition

The hypothesis in Study III, concerning need for cognition, was partly confirmed. No interaction effect was found between question type and need for cognition as was expected. However, a main effect of need for cognition was found. People high in need for cognition were less likely to believe “Somebody else knows” compared to “I know” or “Nobody knows” for both non-consensus and consensus questions.

This result may indicate that when people high in need for cognition find the question difficult to answer by themselves they seem to be more willing to choose the answer option “no one knows” than “someone else knows”. Since people high in need for cognition enjoy abstract and complex thinking (Cacioppo et al., 1984), they may be more tolerant of complex phenomena and therefore more willing to accept that questions may exist that no one today knows the answer to.

Furthermore, people high in need for cognition have also been found to be harder to persuade with new conflicting information when they have already formed a personal opinion (Haugtvedt & Petty, 1992). Therefore, they may be more likely to choose that they know themselves rather than others know in case their own opinion differ with the opinion of others. However, when having less extreme previous beliefs, people high in need for cognition have been shown to be more likely to provide an inconclusive answer to a controversial question (Kardash & Scholes, 1996), an alternative that reminds of our choice “nobody can answer”. People high in need for cognition are also more inclined to be neutral to an ambiguous topic if faced with two-sided arguments than other people (Winter, Krämer, Rösner & Neubaum, 2014).

Optimism

Interestingly, optimists used the alternative ‘cannot be answered today’ more frequently than others in Study I and ‘no correct answer’ more often in Study IV. Thus, optimists were more prone to believe that questions did not have answers today, suggesting that personal optimism may be a counterbalance to

the suggested *human knowledge disposition*. Optimists also judged the illusion questions more often by assessing them as significantly less answerable. The result for optimism in Study IV replicated the result from Study I, that higher optimism was related to the belief that the question could not be answered today. In this study, participants were not instructed about any theoretical view on answerability; instead, we used more natural wordings to ask about beliefs about The Dress colours. Still the relation between optimism and answerability was replicated, which suggests some ecological validity of the relation between answerability and optimism, at least for a Swedish sample.

This may be due to optimists' tendency to try harder than less optimistic people (e.g., Carver et al., 2009). Optimism is also related to self-efficacy (Karademas, 2006; Luszczynska, Gutierrez-Dona, & Schwarzer, 2005). High optimism and self-efficacy may help optimists to accept that questions are not answerable, for example since they are more prone to believe that something good will happen for themselves even if the circumstances are uncertain (Monzani et al., 2014).

However, trait optimism measured with Lot-r may also bias judgments surrounded with uncertainty (Sharot, Christoph, & Dolan, 2011) such as answerability judgments. Baumeister (1989) argued that optimism is adaptive only within limits, and that beyond an "optimal margin of illusion" there may be a "reluctance to admit mistakes or misdeeds". Furthermore, optimism self-rating scales such as the Lot-r that was used in this thesis are also related to healthier aspects of narcissism (Hickman, Watson & Morris, 1996). In line with these research findings, believing "there is no correct answer" could be a way to defend the own personal opinion in case it conflicts with the scientific opinion. People scoring high on narcissism tend to self-enhance by claiming knowledge that they do not in fact have (Paulhus, Harms, Bruce, & Lysy, 2002). People scoring high on personal optimism (and aspects of narcissism correlated with optimism) may be extra optimistic about their own viewpoint when in conflict with the viewpoint of the majority.

Previous experience and previous beliefs

Previous experience is associated with more familiarity, and an initial feeling of knowing the answer, since the question terms are recognised (Reder & Ritter, 1992). In the data-set of Study IV previous experience of the photograph was associated with less frequent use of "*there is no correct answer*". This result could for example be due to that participants with previous exposure get a "feeling of knowing the answer" (Reder & Ritter, 1992). However, the sample of participants who had seen The Dress before

was small ($N = 33$) and these result could also reflect random variations. There are also reasons to believe that increased experience may lead to the belief that “*there is no correct answer*”.

Previous experience of a question may sometimes also be difficult to separate from social influence. People with previous experience of a question are more likely to have memories of other people’s beliefs about an answer, which in turn could affect answerability judgments. However, not all social information may influence answerability judgments, since people search for, believe and remember information from others selectively (Kahan et al., 2011; Mazzoni, Delaney, Nghiem, & Waldum, 2009; Nickerson & Raymond, 1998). In general, people search for belief confirming evidence and are therefore more likely to believe information from others that is in line with their previous beliefs (Munro, 2010; Nickerson & Raymond, 1998).

In general, people are also more likely to incorporate and believe information perceived as good news for themselves (Sharot et al., 2011; Sharot et al., 2012; Sharot & Garrett, 2016). For people scoring high on optimism, this bias in information updating is even more significant (Sharot, et al., 2011). Furthermore, people are more likely to believe information and from people that they have something in common with or trust (Kahan et al., 2012, Van Cappellen, Cornelle, Cols & Saroglou, 2011). Moreover, social influence on ambiguous topics is likely to be more efficient when introduced early in a decision-making process when no firm personal belief has formed (Loftus, 1977; Martin, 1997).

Thus, previous personal beliefs, can be both a hindrance and a facilitator for accepting newly learned scientific results, and therefore hinder for acceptance of a new answer option (e.g., that a question goes from not possible to answer today, to the opinion that there is a solution).

If people do not want to deny new facts completely, they can instead dismiss the whole question as being impossible to answer within science. Munro (2010) found for example that when the own personal belief about an answer was in contrast to the scientific answer, people may argue that the question is not possible to answer within science. This phenomenon is called *the scientific impotence excuse* (Munro, 2010), and can be considered a special form of the popular term “fact resistance”.

Elby and Hammer (2000) described how (Western) philosophers and researchers in epistemology have developed a consensus that a sophisticated knowledge view includes the belief that knowledge is considered tentative and evolving rather than certain and unchanging. Since it may sound more desirable to be considered sophisticated than the opposite, the Western schooling system may communicate these values to a larger extent than for example the Asian (Li, Chen, & Yu, 2006). The drawback would be the just

described form of the phenomenon of fact resistance, by referring to knowledge as uncertain when it conflicts with one's own opinion. Even though evidence is compelling, it may sometimes be socially acceptable to use the “scientific impotence excuse”, at least in Western cultures.

Theoretical implications of the findings

Under this heading I will discuss how the answerability construct was measured, and conclusions of theoretical interest that may be implied from the results from these studies.

Measuring answerability judgments

Answerability as defined above is a faceted construct. It concerns judgments about one's own knowledge, other people's knowledge, and the limits of human knowledge. In this thesis, I used different scale variants to tap into answerability.

In Studies I, II, and III instructions and examples of what was meant by answerability were shown to participants before they answered the questions. The advantage of providing instructions is that it ensures that the participants understand the questions as intended by the researchers. However, this may decrease the studies' external validity. Do people actually receive and use such instructions in daily life? In Study IV, no instructions were provided to guide answerability judgments, but ‘There is no correct answer’ was offered as a possible response. Some people did choose that response, suggesting that they concluded a question could not be answered correctly by anyone. Interestingly, the same relation between optimism and answerability (higher optimism, lower answerability) was found in both Study I and Study IV, which suggests that the relation between answerability and optimism maybe constant, regardless of whether answerability is measured with or without instructions about the construct. However, merely providing the alternative ‘There is no correct answer’ might also influence how people reason about the question, in that it may induce critical thinking about the question itself.

Answerability was graded on a scale in Studies I and II, but Studies III and IV use dichotomous alternatives. An advantage of graded scales is the more detailed statistics that can be computed. The disadvantage may be that this may not be the mental model that most people naturally have. At least some

people may prefer to sort questions into mutually exclusive categories: ‘answerable’ or ‘not answerable’. The relations between optimism and answerability and between certainty beliefs and answerability were replicated when answerability was measured on a graded scale (Study I) and with dichotomous alternatives (Studies III and IV). Consensus questions were also rated more answerable than non-consensus questions on both a graded scale (Study I and II) and with dichotomous options (Study III). Thus, the results of the studies in this thesis suggest that the construct measured with the graded scales is related to the construct measured with the option scales. Taken together these results suggest that measures of answerability are stable in relation to each other.

‘Answerability today’, whether respondents thought anyone could currently answer the question, was measured in all four studies. In Study I, answerability in the future (beliefs about when someone would be able to answer the question) was also measured. These measures were correlated, in that questions considered less answerable today were also considered to be answerable further off in the future. In Studies III and IV, I focused on *who* could answer questions considered possible to answer. For the type of questions considered most answerable in Study I, the most common answer in Study III was that participants knew the answer themselves. Thus, there is both a connection between future and current answerability and a connection between high answerability and knowing the answer oneself. These results may suggest that answerability judgments can include an evaluation of the distance from the self to the correct answer in time and space. I discuss this further below.

Answerability judgments and psychological distance

Trope and Liberman (2010) suggested that temporal distance, social distance, and spatial distance have a common denominator in *psychological distance*. In this section, I offer some proposals on answerability judgments and their relation to judgments about the psychological distance to the answer.

Greater psychological distance is associated with ‘*higher level construals*’. Higher level construals can be considered as relatively abstract, coherent, and superordinate mental representations compared with lower-level construals (Trope & Liberman, 2010, p. 441). Consider the question, ‘What is the name of our galaxy?’ The answer ‘Milky Way’ may represent a lower construal level than ‘Astronomers can answer that kind of question’. A

known answer provided by the person questioned is likely to be more concrete compared to an unknown answer (e.g., ‘I think an astronomer knows’) that may be provided by someone else. When people know an answer, they can describe it in detail because they are aware of the relevant details; it is more difficult for people to describe in detail something unknown to them. A person who has an idea, but not certain knowledge, may answer more vaguely. For example, on the question ‘Who wrote the books *Kris* and *Kallokain?*’, the answer might be ‘I think it was a Swedish writer’. The answerability of questions that people can answer on a personal low level of construal may therefore be rated high on answerability by that person, whether or not their answer is correct.

The results of Studies I and III suggest that judgments about answerability on consensus questions may be associated with short *temporal* and *social distance* to the answers. In addition to beliefs about consensus, the consensus questions that were considered high in answerability in Studies I and III had in common the fact that people were more likely to think that they could provide correct answers to the questions themselves.

In Study III, proportionally more participants (58%) stated that they knew the answers to the consensus questions than the only 27% who claimed to know the answers to the non-consensus questions. Similarly, in Study I, more people thought they knew the answer to the consensus questions than to the non-consensus questions. For the consensus questions the typical answer was ‘Can be answered by me, and maybe someone else’ on the future scale. Thus, the *social distance* to the answer could be considered short for consensus questions rated *high in answerability* (‘I know’ is a shorter social distance than ‘someone else knows’). The results of Study I also showed that questions considered more answerable by someone today were also judged to be answerable sooner in the future. Thus, the *temporal distance* to the answer was judged to be short for questions high in answerability today.

The reference point in construal level theory is egocentric: ‘It is the self in the here and now’ (Trope and Liberman, 2010, p. 440). When judging whether someone else could answer the question, the point of reference is another person’s perspective. Interestingly, the percentage believing that someone else could answer the question was quite evenly distributed over questions in Study III (41.7% for the consensus and 42.4% for the non-consensus questions). The equal numbers may reflect the difficulty of judging what someone else might know about *any* question one cannot answer oneself (compare Kruger and Dunning, 1999).

People who are unaware of a low-level construal answer and have difficulty judging their own or someone else’s psychological distance from a correct answer may use heuristics. I speculate below on two such heuristics:

psychological distance to the question and *psychological distance to a person* providing a low construal level answer.

For the illusion questions, the typical answer in Study I was that ‘someone else’ could provide an answer, and these questions were rated quite high in answerability on the current answerability scale. However, for the consensus questions, the typical answer was ‘I know the answer myself’ (Studies I and III). One explanation may be that people increase their psychological distance from the question when they estimate its answerability. Instead of processing the question item *per se*, (e.g., the illusion question ‘What is the area of an ellipse with a minor axis of 2 cm?’ ‘Is it 4? or 6? What formula should I use to calculate the area?’) the person may judge answerability based on high construal-level domain-specific beliefs about certainty of knowledge such as ‘Physics questions are answerable’ (Stahl and Bromme, 2007). A person with the pre-conception that computational physics questions are answerable when asked a question that by its terms and wording signal its belonging in that domain (compare Reder & Ritter, 1992), may consider that question high in answerability without processing the question on a low construal level and computing the answer.

People may use their *psychological distance* to a person providing an answer as an approximation for the psychological distance to the correct answer. A dear friend is likely to be represented in memory on a lower construal level than an unknown, faraway expert, heard of long ago. Considerable research suggests that people within a short psychological distance are more believable (Johansson & Allwood, 2007; Kahan et al., 2011, Ranu, Dhillon & Kelly, 2015). Other research suggests that people are more likely to believe the opinions of people who share their political, religious, or other values (Kahan et al., 2011; Ranu et al., 2015). Johansson and Allwood (2007) also found that people may rely heavily on a friend’s opinion (from whom they have short psychological distance as defined by Trope and Liberman, 2010) when they do not know themselves.

Answerability judgments as estimations of a vector

A vector is a quantity that has both direction and magnitude. I propose that answerability judgments may sometimes include estimations of a vector in which the starting point is the self and the magnitude is the judgment of the psychological distance (as defined by Trope and Liberman 2010) to the correct answer. The idea that judgments can be described by both direction and magnitude is not new. Busemeyer and Bruza (2012) described judgments in terms of vectors and Yates (2003) described a decision as a course of action, which implies direction.

When the psychological distance to the correct answer is considered short and the direction to the answer is considered clear, it may be likely that the question is considered answerable. If the direction to the answer is unclear, for instance if two or more competing answers are mutually exclusive (e.g., if the psychological distance to ‘no’ may be judged as far as to ‘yes’) the person may be indecisive (Yates et al., 2010) and answerability may be considered low.

If the above reasoning is correct, reducing uncertainty in the direction of the answerability vector and shortening the judgment of psychological distance to a specific answer would increase the likelihood of a person’s believing the question is answerable.

Non-believed perceptions

Estimations of psychological distance and direction to the answer do not seem to be enough to explain answerability judgments. The application of answerability research to colour judgments (in Study IV) revealed a phenomenon denoted ‘non-believed perceptions’. In Study IV some people who perceived a coloured detail in a photograph as white and gold believed that ‘blue and black’ was the correct answer to this ambiguous colour judgment. This finding may be puzzling if answerability judgments are only a judgment of the direction and psychological distance to the answer. Intuitively, one’s own perceptual experience is likely to have a short temporal and social psychological distance to one-self. Inconsistencies in applying construal level theory to other judgments on ambiguous findings have been reported (e.g., Gong & Medin, 2012), and may be due to the difficulty of applying construal level theory, despite how theoretically interesting it may be.

If a person has a low construal level recollection of another person’s memory, the psychological distance to that person’s memory may also be perceived as very short – perhaps even as short as to their own personal experience. In memory research, it has been suggested that people can have vivid vicarious recollections of other people’s experiences and memories (Pillemer, Steiner, Kuwabara Kirkegaard Thomsen & Svob, 2015). It has also been found that when people lack autobiographical recollections of their own, their reconstructed memories (e.g., a childhood event recounted by a parent) can be considered very plausible. People can also have vivid recollections of visual details of ‘non-believed memories’ (e.g., childhood memories that they have been told never happened; Mazzoni, Scoboria, & Harvey, 2010; Scoboria & Pascal, 2016).

Answerability judgments as a metacognitive reality check

Blank (2016) suggested that non-believed memories are a consequence of a healthy metacognitive reality check that draws on general world knowledge and social or other external information. The findings in Study IV that some people have non-believed perceptions may also be explained by such reality checks.

Some people chose to report non-believed perceptions in Study IV, and some reported that the question was not answerable. This suggests that answerability judgments may include judgments about the psychological distance to the correct answer as well as a metacognitive reality check (Blank, 2016) or strategy selection (Reder, 1987). Thus, even if answerability judgments include judgments about the psychological distance to the answer, the results of Study IV suggest that people may also conduct a reality check on their distance to the judgment.

More research is needed to explain the findings about non-believed perceptions. Such research may also better explain answerability judgments. Is it possible that the psychological distance to another person's memory is judged to be shorter, in line with the theory of Pillemer et al. (2016), than the distance to one's own perceptual experience? This question also raises deep questions about the location of the self and metacognitive judgments.

Practical implications of the findings

The purpose of this section is mainly to illustrate how results about question answerability research may be applied in a wider context.

In this thesis, I suggest that consensus effects are important in judging question answerability. In the next section, I will discuss the consequences of consensus effects on answerability for new ideas that require that we *not* think like others. Study II compared individuals' and pairs' judgments of answerability and I will discuss whether one brain is better than two for judging question answerability.

In the two sections following the consensus effect, I will discuss deliberately induced misjudgments of answerability (illusions of answerability), beginning with the creation of questions that seem unanswerable and leading to a discussion on whether it is possible to create an illusion of answerability. Finally, I will address some general implications for decision-makers.

The consensus effect on answerability and innovation

An innovation can, at least sometimes, provide an answer to a question people previously considered impossible to answer in the short term. However, the ‘consensus effect’, people’s reliance on others’ judgments about answerability, is likely to lead to conservatism and discourage innovation. Therefore, in line with Actor Network Theory (ANT; Allwood & Eriksson, 2010), an innovator needs to create a consensus within the target group that the innovation is a good answer to an important question, thus confirming the question’s answerability.

Are two brains better than one when judging question answerability?

When judging question answerability in daily life, is it better to make judgments individually or in groups? The results of Study II suggest that different question types elicited different processes, but which is best may depend on the context. The consensus effect was important in the pair discussions, and non-consensus questions may be rated less answerable by pairs than by individuals. It seemed more time-consuming to address non-consensual questions in pairs if the partners were striving for consensus. It should be noted that the pairs were instructed to try to agree on the ratings before making a written judgment. Although it may be likely, it should not be taken for granted that pairs always strive for consensus in daily life. For example, in a work situation one pair member may have a superior position to the other and therefore think that their view should be decisive. However, even when instructed to come to a consensus decision (i.e., in Study II), pairs in some cases agreed to disagree or made compromises when they could not find a consensus solution about a judgment. This observation indicates the ecological validity of the data.

Individual differences

The results in this thesis suggest individual differences are related to question answerability judgments. However, these results do not imply causality. Do individual differences affect answerability? Is it the other way around? Or is it a mutual relationship? The process of judging controversial issues may activate and influence a person’s epistemological predispositions. Kienhues, Bromme, and Stahl (2008) reported that domain-specific certainty beliefs could be changed through a short-term intervention, and it is possible that performing answerability judgments may affect certainty beliefs.

In the research presented here, people with a stronger belief in the human capability of acquiring true and complete knowledge judged questions as more answerable. Assuming some stability in such a disposition, even if it is changeable over time, it is not unlikely that these people would be more inclined to ask and perhaps also to believe in experts for advice, since they believe someone ought to know if they do not know themselves.

If individual differences affect question answerability, one may ask what individual properties would be good to possess for making realistic judgments of question answerability? This issue is very large and falls outside of the scope of this dissertation and should be attended to in future research.

An optimistic person believing in mankind's efficacy may be more likely not to give up and keep on striving for solutions. However, too much of a human knowledge disposition and belief in mankind's efficacy can cause problems that are difficult and costly to handle (e.g., deposition of nuclear waste).

How to create an illusion that a question is not answerable

Is it possible to create an illusion that a question is less answerable than it actually is? This study indicated that a question may appear less answerable to most people if no consensus is found about the issue in question. Therefore, questioning scientific consensus can be a powerful tool to spread socially induced ignorance about a question already considered scientifically answered. For example, the tobacco industry appears to have wanted the question 'Can smoking cause cancer?' to be considered unanswerable. By spreading conflicting and irrelevant 'research' to convince the public there was no scientific agreement about smoking causing cancer, it was hoped the question would appear less answerable (Proctor & Schiebinger, 2008). An employee of the Brown & Williamson Tobacco Company, cited in Proctor and Schiebinger (2008, p. 1), expressed this strategy in an internal memo with the quotation: 'Doubt is our product'. This story could well repeat itself in other contexts.

How to create an illusion of answerability

Is it possible to make a question appear more answerable than it actually is, thus creating an illusion of answerability? The findings for the illusion questions in this thesis indicate that it is possible to create a 'feeling of others

knowing' even though this may not be the case. Consequently, it may be possible for different actors (e.g., media or domain experts) to convince other people, not as engaged in the topic, to think the answers to unsolvable questions are known, thus creating an illusion of answerability. Exactly how a 'feeling of others knowing' is created needs further research. Even though the illusion questions in this thesis cannot be seen as representative of all possible illusion questions, they may serve as an inspiration for further research on how to create (or maybe avoid) an illusion of answerability.

Implications for decision-makers

When a person claims that a question is possible to answer, I argue that it is important to remember that this is a judgment that can be more or less correct in relation to factual states of the world. Questions that are believed to be answerable may still be unclear, and sometimes there may be unknown easy solutions to difficult problems that we are currently unaware of. Decision-makers could benefit from being aware that answerability judgments sometimes need to be reconsidered. As described above, personal beliefs, individual differences in cognitive style, social interactions, and socially prevalent opinions can bias answerability judgments with illusions of answerability or resistance to compelling evidence.

Limitations

This research is limited in many ways. It is only possible to draw conclusions about how the measured variables in this thesis may affect question answerability. However, these measures may not include all the possible factors that may affect question answerability judgments. For example, I have not taken into consideration motives that could influence how people reason about information (Kunda, 1990) and which could also affect their judgments about question answerability. The questions used as stimuli also limited the results. Even though the questions used in this research covered several disparate areas, other questions may have provided different results. The researchers' categorisation of questions into consensus and non-consensus was supported by the pre-studies, but other categorisations of questions could also be salient to their answerability and interfere with the consensus classification used here. The number of questions in each category may also have affected ratings in different ways even though randomisations were used to avoid fatigue and learning effects. Introducing a definition of an answerable question to the participants, by specifying what we meant by the

question being *answered*, may have contributed to decreased ecological validity since participants might define an answerable question differently in daily life.

The epistemic measures were related to question answerability, but some research suggests that certainty beliefs are not necessarily stable due to individual differences (Broomell & Bodilly Kane, 2017), and the level of the ratings may have been affected by situational factors as well as other individual predispositions or sociocultural factors. The effect of the individual difference variables was, as is often the case in this type of research, quite modest (e.g., Buratti, Allwood & Kleitman, 2013; Dahl, Allwood, Rennemark & Hagberg, 2010), which may challenge the practical significance of these results on a general level. However, for a particular decision, the personal attributes of the individual may be crucial. The causal relationship between the investigated types of individual differences and question answerability also needs further attention. Do individual differences (e.g., certainty beliefs) affect answerability judgments or vice versa? Or is it a reciprocal relationship?

A further limitation is that the sample consisted mainly of Swedish students, so the results may not generalise to other samples. For example, cultural differences in judgment and decision making have been reported between nations (e.g., Yates et al., 1997, 2010). Answerability as such can also be perceived as a complicated concept to investigate, and people more interested in such issues (students) may have been overrepresented in the studies.

The results of the illusion questions provide some evidence that a ‘feeling of others knowing’ can be created. However, even if Study I presents some promising ideas about how to create a feeling of others knowing, it neither explains nor examines the details of *how* that illusion can be created.

Further research

Given that answerability, in the sense used in this thesis, is a very new area of research, many opportunities are open for further study. For example, apart from investigating the stability of the results in this thesis, further research should explore other types of questions, questions from domains other than those explored in this thesis, and more or less understandable questions. Also, the effect of familiarity with the questions on their answerability should be further investigated.

Furthermore, individual differences in beliefs could be further explored, preferably in repeated measures designs. Other categories of people should be tested to investigate whether the results from the participants in this study can be generalised and to investigate the interplay between cultural and individual differences. It would also be interesting to compare experts and non-experts responses about question answerability.

Further research could also focus on the effect of individual differences in answerability judgments. For example, the causality link between certainty beliefs and question answerability needs further attention, as does the causal mechanisms related to the relation between optimism and answerability.

An assumption was made in the thesis that more deliberate thinking may be associated with pair discussions of non-consensus questions. However, this does not exclude the possibility that some pairs reached a quick conclusion on some questions that they reckoned no one could know. As an addition to the quick and slow personal 'don't know' judgments investigated by Koelers and Palef (1976) and Glucksberg and McCloskey (1981), further research could benefit from investigating when and why quick and slow 'no one knows' judgments are made, both individually and in pairs.

The illusion questions provide an intriguing area of research with ethical undertones. How is it possible to create or prevent a feeling that others know, when they do not? The question is important to investigate since it is possible to use such strategies to both avoid and to create an answerability illusion. However, more research is needed to investigate the mechanisms of the 'feeling of others knowing' and the 'feelings of others not knowing'.

Several applied areas would benefit from more research into question answerability. For example, in many situations when a person or an organisation considers consulting others for help, advice or answers are likely to include question answerability judgments as an important decision-making step (e.g., witness interrogations and managerial decision making). Since social interactions may affect answerability judgments, the decision processes of experts and influential persons need attention. For example, which differences in answerability judgments would be found when experts work in cross-functional teams, rather than alone, in the context of treating a patient or solving a technical problem? One applied area of interest for question answerability is in medical decision making. This is particularly relevant since features enlightened by research in embodied cognition (Borghi & Cimatti, 2010) may affect the answerability judgments for the patient in ways different to those for medical experts. For example, question answerability about the body is likely to be affected by bodily sensations (e.g., pain) and the brain's representation of the body (Moseley, Gallace & Spence, 2012). On the other hand, question answerability about another person's body may

be associated with individual differences related to embodied cognition such as empathy (Asai, Zhu, Sugimori & Yoshihiko, 2011).

Another area where the framework of answerability judgments could be applied is climate science. People's beliefs about climate science have been hotly debated and scientifically studied (e.g., Häkkinen & Akrami, 2014; Kahan et al., 2012) and research on judgments about question answerability would contribute to that body of research.

Finally, this thesis' unexpected findings about non-believed perceptions of colours also inspires further research. These findings suggest further research on colour judgments in connection with research on metacognition (e.g., Blank, 2016), non-believed memories (e.g., Mazzoni et al. 2010; Scoboria & Pascal, 2016), and beliefs about colour constancy (e.g., Brainard et al., 2006). Is seeing judging?

Conclusion

This thesis contributes by describing and investigating a specific type of judgments: answerability judgments. Answerability concerns the judgment of whether anyone can provide a correct answer to a particular question. Such judgments can be important when making individual and social decisions; answerability judgments can affect subsequent important judgments and decisions (e.g., if a person believes that no one can provide a correct answer about global climate change, this person will most likely be less motivated to engage in actions against global warming). Basic research on answerability judgments can provide insights in applied areas such as managerial and medical decision making, climate science, and any area where a person or an organisation consults someone else for guidance. An increased understanding of answerability judgments can also provide insights into basic psychological research into non-believed memories, future intentions, confidence judgments, and cognitive processing of ambiguous and incomplete perceptual stimuli.

Judgments of answerability include judgments of both whether a question is possible to answer by anyone today (current answerability) or by someone in the future (future answerability). Answerability judgments also include beliefs about which person, if any, can answer a specific question. Results in this thesis showed that questions considered more answerable today were also considered more answerable in the near future, and questions where a concrete answer could be provided were considered more answerable,

suggesting that answerability could include judgments of psychological distance from the self to the question.

The studies in this thesis also suggest that the opinion of relevant others may influence a person's answerability judgments strongly. People generally tend to agree with most others in answerability judgments. However, individual differences were also related to answerability judgments, especially on questions where there was a lack of consensus if the question was answerable (non-consensus questions).

When judging general knowledge questions, higher current answerability judgments were associated with more optimistic beliefs about mankind and mankind's knowledge and with maximising tendencies. Participants who believed in mankind's efficacy believed that questions would be answered sooner in the future. In contrast, optimistic beliefs about the self were associated with low short-term answerability judgments about non-consensus questions and illusion questions. People with a high need for cognition were less likely to believe that someone else could provide an answer.

Contextual associations such as recent knowledge activation, through reflecting alone or discussing in groups, is likely to influence answerability judgments. More stable contextual associations, such as general beliefs about the knowledge in a certain knowledge domain may also colour the answerability of questions and possibly create an illusion of answerability. When applying the answerability framework to judgments about the colours in an ambiguous photograph, some people may believe there is no correct answer about colours, or that the colours they perceive themselves are incorrect. Previous experience of the photograph was associated with the question becoming more answerable

The results of this thesis suggest that a persons' belief about the answerability of a particular question can be affected by social consensus and communication strategies. Depending on individual differences in optimism, views of knowledge, and other factors, people may arrive at different conclusions about answerability and these various factors warrant further research.

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Appendix A

Questions used in Studies I, II, and III

The knowledge questions used in Studies I, II, and III are listed by category below. Three categories of questions were used: consensus, non-consensus, and illusion. Questions marked with an asterisk* were used in Study I. Modifications to fit to the future answerability scale in Study I are shown in parentheses and marked /xxx/*. Questions in *italics* were used in Study II. Four questions used only in Study II are presented under a separate heading (“Non-consensus questions used only in Study II”). Both non-consensus and consensus questions were used in Study III.

Except for the questions used only in Study II, the battery of questions was initially developed in Pre-study 1, and validated in Pre-studies 1 and 2 (pre-studies are briefly reported in Appendix C). In Pre-study 1, questions were presented in pairs according to the following 25 domains: Swedish grammar, Stock trading, Soccer, Galaxies, Dog breeds, Mechanics, Political science, Authors, Programming, Climate science, Politicians, Vitamins, Flowers, Space, Cooking, Geometry, Measurement units, Physics, Medicine, Databases, South American history, Diseases, Ticks, Summer songs, and Technology. Pairs were constructed so that all three categories were combined and spread among pairs as much as possible. Respondents were asked to judge answerability either on a current answerability scale or a future answerability scale; no titles were used.

Consensus questions

- Which word-class does the word “beautiful” belong to? (Swedish grammar)*
- *Where is the main office of NASDAQ located?* (Stock trading)
- What is Zlatan’s surname? (Soccer)
- What is the name of our galaxy? (Galaxies)*
- In what country will the World Cup be played in 2014? (Soccer)
- Which breed is considered the smallest? (Dog breeds)
- What is the usual nose colour of a German Shepherd? (Dog breeds)

- What does m stand for in the formula $F = ma$? (Mechanics)
- Which department is responsible for, among others, the police, the prosecution, the courts, and the correctional facilities (Political science)
- *Who wrote the books Kris and Kallockain?* (Authors)
- In the coding language Pascal, the code begins with the command 'Begin'. What does it end with? (Programming)
- What is the name of the Swedish Minister of Foreign Affairs? (Politicians)
- *How many petals does a blue anemone usually have?* (Flowers)
- *Which flower is called Anemone Nemorosa in Latin?* (Flowers)
- What is a super-nova? (Space)*
- What do you call the mixture of flour and water that you can add to a sauce to make it thicker? (Cooking)
- The formula for the circumference of a circle is denoted $\pi * D$. What does D stand for? (Geometry)*
- How many centimetres make one inch (measured to one decimal)? (Measurement units)
- This vitamin is provided in drops to children and can be acquired through sunlight. What is the vitamin called? (Vitamins)
- What is a database called that usually consists of several tables of relations? (Databases)
- Who wrote 'Sommaren är kort' ['Summer is short']? (Summer songs)
- In 'Den blomstertid nu kommer, med lust och ...' [The time of flowers is approaching, with pleasure and...], what are the next two words? (Summer songs)

- What is the voltage if the electric current is 10 amperes and the resistance is 15 kilohms? (Physics)*
- The virus that causes chicken pox can also cause another disease. Which one? (Diseases)*
- What is another word for the branch of medicine that deals with the uses, effects, and modes of drugs? (Medicine)*
- In which century did Columbus start the European colonisation of South America? (South American history)*

Non-consensus questions

- *How many varieties of the word "snow" did humans have during the ice age?* (Swedish grammar)*
- Which stock is the most profitable to buy? (Stock trading)
- *How many galaxies are there in the universe?* (Galaxies)*
- Is there any department that would be more efficient if divided into two or more units? (Political science)
- What proportion of all diseases have psychological causes? (Diseases)*
- What proportion of authors in the world have had major economic troubles? (Authors)
- Which programming language is the best for embedded systems? (Programming)
- *Who will be the next prime minister of Sweden?* (Politicians)
- How much vitamin C do you get by eating carrots? (Vitamins)
- *Which method is the best to heat fish?* (Cooking)
- *How many species of bacteria can be transmitted to humans through ticks?* (Ticks)*

- *How much environmentally hazardous material does the /anno 2014/* most common laptop contain? (Technology)**
- *Are humans causing the greenhouse effect? (Climate science)**
- *Will the polar ice caps melt in 500 years? /before year 2514/* (Climate science)**
- *Is there life in space? (Space)**
- *What kind of database is the best to use if you are running a small company? (Databases)*
- *Is there /anno 2014/* a safe technology for storing nuclear waste? (Technology)**
- *Does the vaccination /used year 2014/* provide safe protection against tick-borne encephalitis? (Ticks)**
- *Did the Mayans have any knowledge about the end of the world? (South American history)**
- *Does the human body /anno 2014/* have a circulatory system that is as yet unknown? (Medicine)**

Non-consensus questions used only in Study II

- *Are congestion charges good for the environment?*
- *Can you become allergic to electricity?*
- *Can genetically modified fruits and vegetables be dangerous to nature's ecological systems?*
- *Is radiation from cell phones dangerous?*

Illusion questions

- *What is the kinetic energy (measured in joules) of a vehicle moving at 90 km/h? (Mechanics)*

- What is the area of an ellipse with a minor axis of 2 cm?
(Geometry)*
- What is the electric power at a voltage of 100 volt? (Physics)*
- How many Newtons correspond to 3 kg/s^2 ? (Measurement units)

Appendix B

Measures

Belief in certainty of knowledge (Bråten & Strømsø, 2005)³

- If scientists try hard enough they can find the truth about almost everything).⁴
- Scientists can ultimately get to the truth.
- Educators should know by now which is the best method: lectures or small group discussions.
- If professors would stick more to the facts and do less theorising, one could get more out of college.

Mankind's efficacy

- Mankind can always manage to solve difficult problems if it tries hard enough.
- Even if hard times threaten mankind, mankind will find ways to reach its goals.

³ The selected questions for beliefs about certainty of knowledge were intended to tap the participants' attitudes towards the possibility that any human could have certain knowledge. The choice of suitable items for measuring beliefs in certainty of knowledge has been discussed (e.g., Schraw et al., 2002), but even critical research has found that some items associated with beliefs in certainty show stable internal consistency across measurement occasions (Clarebout et al., 2001). Items were therefore selected that would be: (1) associated with certainty beliefs, in the sense that any human may have access to certain knowledge, and (2) relevant to question answerability. The four items above were associated with the certainty factor by Bråten and Strømsø (2005). Higher scores indicate higher belief in certain knowledge. The items were rated on a 5-point Likert scale, from 1 = Do not agree at all to 5 = Totally agree.

⁴ *Only the first two items were used for analysis in Study I, although all four items were included in the questionnaire. Analyses were made with all four and with only two items; conclusions in Study I did not change with the change in items, but Cronbach's alpha was better using only the first two items. All four items were used in Study III.

- In unexpected situations, mankind will find ways to act.
- Even in unexpected situations, I believe mankind can cope well.

Mankind's knowledge

- How much does mankind know of all there is to know?
- How much does mankind know of all that is important to know?"

Appendix C

Pre-study 1

The main aim of Pre-study 1 was to explore answerability judgments on 50 questions listed in appendix A. We had divided the questions into three categories: consensus questions, non-consensus questions and illusion questions and wanted to explore if participants rated these categories different on current answerability. Furthermore, four individual difference measures were included for explorative purposes in order to investigate if answerability judgments were related to these individual difference measures. We also wanted to explore possible differences in readability between the consensus and non-consensus questions.

Method

Participants. One hundred students and employees⁵ from Nova Research and Development (a centre for post-secondary education and municipal development) in the town of Oskarshamn, Sweden, participated. There were 32 men and 67 women⁶; the mean age was 36 years (range 19 to 66). Each participant was reimbursed with a lottery ticket worth approximately US\$ 5.50.

Materials. Materials consisted of an answerability questionnaire, ‘Belief in Certainty of Knowledge’ (described below), and three other

⁵ In total, 125 participants answered the questionnaire, but 25 were excluded because they misinterpreted the scale. Eighteen of those 25 interpreted the scale as ‘what percent of Sweden’s population can answer the question?’ This alternative interpretation was identified in pre-tests and measured by a manipulation check multi-alternative question. This interpretation could be a misunderstanding, but it could also serve as a (limitedly) legitimate strategy for judging question answerability.

⁶ One person did not answer the gender question.

measures of difference, which, in the interest of brevity, will not be described. These measures were the Maximizing Tendency Scale, the Memory and Reasoning Inventory, and the Rosenberg’s Self-esteem Scale.

Answerability questionnaire. A questionnaire with 50 questions was prepared (see Appendix A). The answerability judgment scale ran from 0% (*Cannot be answered*) to 100% (*Can be answered*) in intervals of 10% (Figure 1).

Current answerability scale

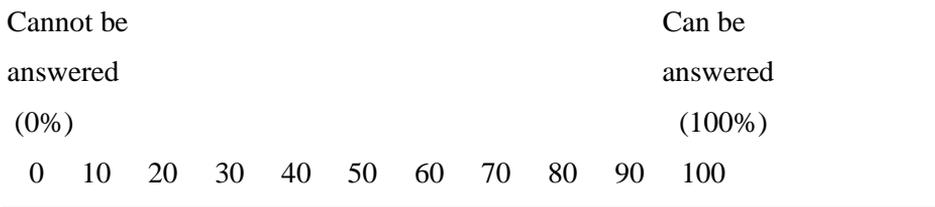


Figure 1. The answerability scale used in Pre-study 1.

Certainty beliefs. We used four items from a factor tapping beliefs in *certainty of knowledge* in the epistemic beliefs measure presented by Bråten and Strømsø (2005). Cronbach’s alpha was .75 (items are listed in Appendix B).

Individual difference measures. Three other individual measures (mentioned at the end of the first paragraph of this section) were also collected but are not reported in detail.

Procedure. The test battery was administered in a controlled classroom setting in small groups of approximately 10 to 30 people. Participants first completed the answerability questionnaire, then three questionnaires tapping the three scales mentioned above, and finally, the ‘Belief in Certainty of Knowledge’ questionnaire.

Results

Mean values of the answerability judgments for the respective questions varied from nearly 100% to about 20% answerability. As expected, consensus questions were perceived to be most answerable ($M = 88\%$), followed by illusion ($M = 80\%$), and non-consensus questions ($M = 48\%$, see Table 2. A repeated measures ANOVA with a three-level repeated measure (question type: consensus, non-consensus, and illusion) showed there was a significant difference in answerability level between the three question types, $F(2,190) = 187.67, p < 0.001$, generalised $\eta^2 = .41$. Post hoc analysis with Bonferroni correction showed that all three groups differed significantly from each other ($p < 0.05$).

Table 2. Mean values of Current Answerability for Consensus Questions, Non-Consensus Questions and Illusion questions.

	M%	SD
<u>Question type</u>		
Consensus	88	17
Non-consensus	48	18
Illusion	80	25

Note. Current answerability was measured on a current answerability scale where 100% = Can be answered today; 0% = Cannot be answered.

Certainty beliefs. Certainty beliefs were only correlated with the answerability ratings for the non-consensus questions, $r(94) = .38, p < 0.001$. That is, greater belief in certain knowledge was associated with higher answerability judgments for these questions.

We also wanted analyse the extent to which beliefs in certainty of knowledge were associated with extreme judgments about answerability. Therefore, we computed the total number of times the scale-ends 0% and 100% were used for the three types of questions (certainty, non-consensus, and illusion). Two correlations, between certainty beliefs and the frequencies of 0% and 100% answers were computed. Higher certainty beliefs were associated with less frequent use of 0% (*Cannot be answered*), $r(95) = -.29$, $p = 0.004$. However, there was no significant correlation with 100%.

Individual difference measures. We did not find any significant correlation between the three other individual differences measures and answerability judgments.

Readability. Since we wanted to explore if the non-consensus questions may be harder to read and therefore harder to grasp then the consensus questions, we analysed these questions on readability, that is, how easy they are to read. We used a standardised computation tool, the automatic readability index (ARI), an index that takes the number of letters, words and sentences into account (see Rajendar & Kumar, 2012). There were no significant differences in readability between the consensus and non-consensus questions.

Discussion

We concluded that participants separated the questions that we denoted as consensus questions from non-consensus questions, and that this division could be useful for further studies. We also concluded that the illusion questions were considered special and could be an interesting category in further studies.

Since certainty beliefs correlated with answerability judgments of non-consensus questions, we decided to investigate this measure once again in

relation to the current answerability judgment scale (in Study I). The lack of correlations between consensus questions and individual difference variables may be caused by a ceiling effect inducing a restricted range in answerability for the category. However, it may also be due to a “true effect” of individual differences asserting themselves more when consensus effects are less prevalent.

Since we did not find any correlations between the other measures we concluded not to use them in relation to this scale type on answerability. One reason for the lack of significant differences between answerability and the individual difference measures might have been that ‘I know the answer’ was not separated from ‘Someone else knows the answer’. If doing so, some of the measures may be more interesting to use in future studies, since they may be related to differences in beliefs about own knowledge versus others’ knowledge.

Pre-study 2

The purpose of Pre-study 2 was to investigate whether the classification of consensus and non-consensus questions was valid. We wanted to validate that other persons agreed with us that the majority of the Swedish population would believe the consensus questions were possible to answer, while fewer people in Sweden would believe the non-consensus questions were answerable. We also wanted to explore whether participants felt that they understood the questions we asked, as different abilities to understand the questions may lead to different judgments about answerability.

Method

Participants. 100 participants from a student pool at the University of Gothenburg answered a web survey.

Materials. We used the 50 question items from Pre-study 1 (listed in Appendix A). Participants estimated, for each of the 50 items, the proportion of Swedes that would consider the question to be answerable (on a scale from 0% to 100%). Participants also rated the 50 questions on their understandability on a scale ranging from 0% (totally impossible to understand) to 100% (totally understandable).

Procedure. Participants first rated the 50 question items on the proportions of Swedes that would consider the question answerable and after that rated the 50 items on understandability.

Result

Estimated consensus about answerability in the Swedish population. On average participants judged that 78% of the Swedes would consider consensus questions answerable, but estimated that only 54% of the Swedish

population would regard non-consensus questions answerable. Participants further believed that 66% of the Swedes would judge the illusion questions to be answerable. The difference in estimated answerability between consensus, non-consensus, and illusion questions among Swedes was significant $F(2, 47) = 72.31, p < 0.001$ which supported the researchers' intuitions. Bonferroni post hoc tests showed that all question categories differed significantly from each other ($p < 0.01$).

Understandability. Consensus questions were rated most understandable ($M = 90, SD = 1.7$), non-consensus questions second ($M = 74, SD = 1.9$) and illusion questions least ($M = 72, SD = 4.4$). The difference was significant $F(2, 47) = 23.3, p < 0.001$. Post hoc tests with Bonferroni correction ($p < 0.001$) showed that consensus questions had a higher rated understandability than both non-consensus and illusion questions. However, no significant difference was found between illusion and non-consensus questions.

Discussion

The results supported that the categorisation in consensus and non-consensus was valid. If almost 80% of the Swedish people believe a question is answerable, it could be considered that consensus exists that the question is answerable. However, if only half of the population believe the question is answerable, this may be interpreted that there is not a clear consensus that the question is answerable in the Swedish population.

Regarding understandability the consensus questions were rated as more answerable than the non-consensus and the illusion question. Since consensus questions were rated as more answerable in Pre-study 1, understandability can be related to answerability in the sense that questions that are perceived to be better understood are also perceived more answerable. The illusion questions may be special in relation to

understandability since we may expect a larger spread both in understandability and answerability on these items. A person that is somewhat familiar with the terms in the illusion question or a person that is very familiar with the terms and processes the illusion question on a shallow level, may believe that somebody else can understand and answer the question (or the person self if given more effort and time). However, for a person with deeper knowledge that processes the question thoroughly, an illusion question may seem totally understandable and also not possible to answer, for example since it may be perceived as a trick question.