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A Study of the Interplay between Intuition and Rationality in Valuation Decision Making

Abstract

There is widespread acceptance that both intuition and rationality can play significant roles in valuation decision making. However, a study that specifically examines how intuitive and rational approaches interact is still missing. This study addresses this gap by applying cognitive theories of information processing and using a very detailed analysis of verbal protocols to propose a model of cognitive structure that identifies and describes the reasoning of property valuers during a commercial valuation task. The empirical data suggest that valuers start with an established goal and then engage in analytical and intuitive thinking until a valuation outcome has been reached. It is argued that a major reason for effective valuation decision making, in a real-world context, is that the cognitive processes required by experts' analytical and intuitive thinking demonstrate greater degree of cohesiveness and interestedness. The ability of valuers to integrate more intuition into their largely rational decision making process suggests the need for valuation professional organisations to formally acknowledge intuition as an important component of valuation professional competence and skill requirement and to customise professional valuers' training and development programs to facilitate the development of appropriate intuitive approaches for effective valuation decision making

Keywords:

Commercial property, valuer, intuition, rationality, valuation decision making

Introduction

The property valuation profession has been playing a premier role in our societies by supporting individuals, public organisations and private businesses in establishing market values for properties in a variety of financial decisions such as performance measurement, taxation, acquisition and disposal (Baum et al., 2000). Also, valuers play a major part of restoring normalcy and trust to property markets (Coester, 2015), which is central to efficient functioning of a country's economy, society and the environment (Wilkinson et al., 2017). In the property literature, valuation decision making is conceptualised as a predominantly rational, analytical and step-by-step process (Whipple, 1990; Amidu and Boyd, 2018). However, Diaz (1990a; 1990b) and Diaz et al. (2002) argue that optimal valuation decision making may require departure from the preferred rational approach to a more intuitive approach, which uses heuristics (rules of thumb) in order to overcome natural processing limitations due to time or restricted information (Kahneman, 2011).

Although intuitive and rational reasoning are both recognised in the literature as valuable for the valuation practice (Amidu and Boyd, 2018), very little is known about how they interplay in decision making. This paper bridges this gap by exploring the reasoning processes in valuation practice. In particular, given a complex valuation problem, do valuers come up rapidly with a solution by intuition, or do they more slowly search through the states of the problem space? In the expertise literature, numerous answers have been proposed. Some rely exclusively on intuition, others exclusively on analytical thinking, and still others propose a combination of both, either in sequence or in parallel. The aim of this paper is to shed light on this question using the domain of commercial property valuation.

A typical commercial valuation task often requires valuers to use different sources and qualities of information and to cope with unpredictable, non-routine and complex situations (Crosby et al. 2018; Klamer et al. 2017). In addition, significant parts of the commercial valuation process require valuers to exercise professional judgment on a wide range of issues, including the choice of valuation methods and input data (Millington, 2014; Ratcliff, 1975). Commercial property valuations, therefore, tend to rely heavily on intuition and analytical thinking (Amidu & Boyd, 2018). A deeper understanding of how these reasoning processes interplay in information processing and decision making can have implications for valuers' continuous skill development, and in particular would provide important insights for practicing valuers and those involved in designing valuation courses.

Apart from educational goals, a thorough understanding of valuers' judgment behaviour is critical to professional autonomy. Classical definitions of professional work assume that professionals enjoy a high level of autonomy of decision making and control when using their professional knowledge and skills (Larson, 1977; Freidson, 1994). However, professional valuers who are members of professional

organisations such as the Royal Institution of Chartered Surveyors (RICS) are also expected to adhere to a set of professional standards and procedures (Crosby et al., 1997; Mallison and French, 2000; McParland et al., 2002). This control is meant to improve valuation quality and reduce uncertainty in the process (Croby et al., 1997; 2018). However, at first sight, it contradicts the professional valuers' need for autonomy. Hence, the dilemma facing the property valuation profession, like many professional groups, is how to foster social and self-control mechanisms that will encourage professional valuers to consider their professional organisation's interest (i.e. by following openly available rules and best practices) while working to a high degree of autonomy in their judgments and decision-making. This research focuses on one possible approach to answering this question, namely using theories of cognitive information processing. These theories have a psychological basis that sees individual cognitive mechanisms and working modes as key determinants of professionals' behaviour. This contrasts with phenomenological theories which do not acknowledge cognitive processes. The study will exclusively use cognitive theories to explore the interplay between two parallel and continuously operating information processing modes – rationality and intuition (Sloman, 2002; Harters and Grubers, 2008; Calabretta et al., 2017) – in the highly professionalised context of commercial property valuation. We will show that theories based exclusively on intuition or analytical thinking are difficult to reconcile with the behaviour of professional valuers. In addition, rather than relying on intuition in a first state and on analytical thinking on a second stage, experts continuously use a combination of intuition and analytical thinking.

Literature Review

Rationality and Intuition in Valuation Decision Making

In property valuation literature and practice, the rational mode of working is implicitly or explicitly portrayed as the model to strive for, even if uncertainties and market conditions prevent a valuer from undertaking a completely rational process (Whipple, 1990; Amidu and Boyd, 2018). Rationality is typified as an analytic, deliberative, rule-governed and explicit mechanism for problem solving and decision making (Hodgkinson and Healey, 2011). Expert valuers preferring this mode of working use a systematic and step-by-step decision-making process, which consists of seven steps: *(1) problem definition; (2) preliminary analysis, data selection, and data collection; (3)highest and best use analysis; (4) derivation of a land value estimate; (5) estimation of value as improved; (6) reconciliation of approaches to value estimation employed in previous step; and (7) reporting of the value estimate to the client (Appraisal Institute, 2007).* Kinnard (1991) and Dasso et al. (1977) conceptualised the valuation process as involving four major tasks: (a) preparation of an outline; a plan or blueprint for action by the valuer; (b) assembling materials for analysis of market and property data; (c) applying appropriate tools of analysis: analytical techniques and approaches; and (d) applying judgement to reach a conclusion in terms of decision standards. Other researchers maintained that valuation is a problem-solving process involving three functions: analysis and interpretation of both the problem (definition of

value of an interest) and property (physical, legal, locational and environmental attributes) and prediction of market value (Whipple, 1990) through the application of valuation methods. As with all rational decision processes and given its systematic and structured nature, the valuer's general decision process can be slow, time-consuming and effortful, and therefore not always appropriate to cope with the unpredictable, non-routine and complex situations that valuers deal with from time to time (Amidu, 2011, Diaz et al., 2002).

In such situations, valuation professionals can use an intuitive decision-making process (Diaz et al., 2002). In the psychology literature, intuition is often referred to as a domain-specific reasoning mechanism that enables appropriate judgments and decisions to be reached through rapid, non-conscious recognition of patterns and associations (Myers, 2002; Dane and Pratt, 2007). Intuitions are valuable in their own right (Kahneman, 2011) and can be as powerful and accurate as analysis (Klein, 2003). Apart from helping valuers to deal with the complexity of valuation task, especially in a commercial property context, where there may be multiple or no predetermined solution paths, and where there is uncertainty about which data, concepts and principles are relevant for the solutions (Baffour Awuah and Gyambi-Yeboah, 2017), intuition also stimulates those creative reasoning processes that are essential to the generation and exploration of challenging problem solutions and ideas during valuation problem solving (Amidu et al., 2019a).

In an intuitive valuation decision making process, evidence suggests that the valuer's performance systematically deviate from the rational norm (Diaz 1990a; 1990b; Diaz et al., 2002), and that valuers use heuristics instead of following the correct rules of logic (e.g., Hansz, 2004; Diaz and Hansz, 2010; Tidwell and Gallimore, 2014). These authors, and many other researchers in their footsteps, have produced evidence that valuers relied on contextual cues (such as third-party value estimates, pending sales or mortgage amounts and recent transaction price) and engaged in cognitive shortcut strategies that humans routinely use when making judgments in complex situations, that is, judgment by representation, judgment by availability, and judgment by anchoring and adjustment (Tversky and Kahneman, 1974). These studies also suggest that valuers are more likely to deploy these heuristics-related behaviours particularly when engaged in an unfamiliar market setting. For instance, in a series of experimental studies on acquisition and adjustment of comparable sales information, Diaz (1990b) found that expert valuers used a less cognitively demanding selection-strategy guided by use of less information. Gallimore (1996) found that UK valuers who have knowledge of sale price turn to limit their search effort of comparable in support of their valuation opinion. The use of less information by expert valuers is attributable their experience and a solid and complete knowledge and awareness of the decision-making context, which give them an advantage in recognising the important cues without any detailed comparative analysis of all available information (both relevant and irrelevant).

Although there has been a great deal of research focusing on examining the attributes of either rationality and intuition as core information processing mechanisms, there is a widespread agreement that valuation decision making and problem solving may require both (e.g. of Amidu and Boyd, 2018; Diaz and Hansz, 2007). An understanding of how rationality and intuition interact during valuation decision making is, however, yet to be established in valuation behavioural literature.

Reasoning and Expertise

Within the wider cognitive psychology literature, opinions currently differ as to how the intuitive and rationale information processing systems influence expert decision making behaviour. Several authors have argued that intuition, which occurs in matters of seconds, lies at the heart of expertise, leaving little else to explain for slower thought processes. In a very influential theory, Dreyfus and Dreyfus (1986) argue that expertise is intuition and that experts rarely carry out analytical thinking with ordinary tasks: "experts don't solve problems and don't make decisions; they do what normally works" (Dreyfus & Dreyfus, 1986, pp. 30-31). According to these authors, when experts spend a long time deliberating about a problem, they do not carry out analytical search; rather, they reflect on their intuitions and on why they went wrong. Similarly, Gigerenzer (2007) argued that experts use simple heuristics that lead to intuitions and allow them to simplify problems and thus to avoid slower search. Finally, proponents of situated action propose that experts use their perceptual skills to extract the critical information in the environment, again avoiding the need for more analytical thinking (Suchman, 1987).

By contrast, some theorists have argued that experts draw their expertise from the fact that they can better analyse and search through the space of possible solutions. For example, Holding (1985) argued that skill in chess consists in carrying out search efficiently. In medicine, authors such as Elstein et al. (1978) proposed that experts use better hypothetico-deductive methods to generate hypotheses and test them. While these authors do not deny the importance of knowledge, they downplay the role of the kind of implicit knowledge that is characteristic of intuition.

Finally, some authors have argued that both intuition and analytical thinking play an important role (Kahneman, 2011; Harteis and Grubers, 2008; Calabretta et al., 2017). Based on his dual system theory, Kahneman (2011) argues that experts first try to solve a problem by intuition; if this fails, they then use a second, slower system, characterised by analytical thought. An important aspect of this theory is that the application of the two systems is serial and exclusive. By contrast, Gobet (1997) proposed a formal model (SEARCH) that proposes a nearly constant interaction between intuition and search. During search, pattern recognition is used recursively to suggest actions and heuristics for selecting actions. While the SEARCH model agrees with Dreyfus and Dreyfus (1986), Gigerenzer (2007) and Kahneman (2011) that the first phase of problem solving is essentially based on intuition and pattern recognition, the crucial difference compared to the other models is that SEARCH assumes that pattern recognition

is also used later when individuals search through various possibilities, for example, in chess, when they generate alternative white and black moves.

The theories we have reviewed above make clear-cut predictions about the way experts and non-experts solve difficult problems. Theories based on intuition (Dreyfus & Dreyfus, 1978; Gigerenzer, 2007) and situated action (Suchman, 1987) predict that novices, who lack expert intuition, will carry out analytical search; by contrast, experts will rely on their intuition to rapidly come up with a solution. In addition, Dreyfus and Dreyfus predict that, with difficult problems, experts will reflect on their intuition – a type of metacognition. Theories emphasising analytical search or hypothetico-deductive reasoning, such as Holding's (1985) and Elstein et al.'s (1978), predict that both novices and experts will carry out analytical search, but the latter will be more efficient than the former due to the techniques they have mastered during their academic training and later during practice; intuition should play no role. Kahneman's (2011) theory predicts that problem solving will first have an intuitive phase, followed by an analytical phase with little use of intuitions. Finally, Gobet's (1997) SEARCH predicts that intuition and analytical search will be interleaved during most of problem solving.

Most authors agree that what de Groot (1965) called the "first phase" – where individuals orient themselves in the problem situation and make an initial rough evaluation – is mostly intuitive in nature. The disagreement is about the processes involved in the main part of problem solving, what de Groot called "progressive deepening". The aim of this paper is to address the different predictions that the theories discussed above make about this second phase. To do so, the current study will ask novice, intermediate and expert practitioners to think aloud when establishing the valuation of a commercial property. The analysis of the verbal protocols will determine the knowledge states and the problem-solving operators (see below), and provide a mapping of practitioners' thought processes that will then be synthesised into a descriptive model of expert valuers' cognitive structure.

Methodology

Cognitive behavioural research is set within a realist positivistic philosophy and investigations involve methods for determining cognitive processes. Thus, this research adopted an experimental method where experts, with various proficiencies, were given a property valuation task during which their cognitive processes were studied using verbal protocol analysis. The results were analysed in an in-depth qualitative manner to deduce these cognitive processes.

Participants

There were three groups of participants: (a) participants who had no practice experience in commercial property valuation (the novice valuers), (b) participants who had only a little practice experience in

commercial property valuation (the intermediate valuers), and (c) participants who had greater level of practice experience in commercial property valuation (the expert valuers). The research used years in commercial valuation practice and professional and peer recognition as the criteria for identifying expert valuers. Absence of professional recognition was used to identify the intermediate valuers who were real estate graduates but still undergoing practical training (that is, RICS Assessment of Professional Competence (APC) students). Finally, absence of experience was used to identify the novices who were real-estate students at the final year of their academic training. Ethical approval was obtained for the study.

Table 1 presents the background information on each participant as at the time of data collection. Two experts and one intermediate valuer were recruited from large, private-equity partnership real-estate firms in metropolitan Birmingham, UK. Participants working in private firms were chosen because they would have had many valuation encounters to bring to bear on the simulated valuation task. One intermediate valuer was recruited from the Birmingham City Council where he is currently undergoing APC training, but in a valuation pathway. All the novice valuers were final year undergraduate real-estate students at a UK University.

The participants' valuation experience ranged from 0 to 22 years. This demonstrates a wide level of experience, with participants potentially at different phases of development of cognitive and problem-solving ability. Note that expert valuer 1 did not complete a university degree in real estate. Instead, he completed the RICS examinations to gain his professional membership. He thus had less formal education as compared to other participants. The advantages of this and the fact that participants were in varying stages of cognitive development and problem-solving abilities are that there is the potential for increased richness in the data collected and a diversity of perspectives for providing an understanding of how valuers utilise their cognitive expertise.

Verbal Protocol Analysis

Verbal protocol analysis is a research method in which verbalisations of participants' thoughts are elicited and transcribed for analysis (Ericsson & Simon, 1980; Gobet, 2009). The method requires participants to "talk aloud" or "think aloud" when performing a task, for example solving a valuation problem, with the explicit instruction to verbalise everything that comes to their mind. As argued by Ericsson and Simon (1980), these think aloud procedures do not change participants' thoughts because they are verbalised as information is being processed. Rather, the procedures help to minimise the potential hazards of inferences about behaviour. Verbal protocols can be generated either retrospectively or concurrently. The latter was adopted in this study and entails asking participants to think-aloud while performing the task. This approach was preferred over retrospective protocols to ensure that participants did not reconstruct events that did not actually happen during the valuation task.

Task

Collecting data through the verbal protocol analysis method involved presenting a problem task to participants, requesting them to think-aloud while performing the task and audio-taping the think-aloud sessions. The task for the think-aloud sessions of this research consisted of an observed, simulated valuation in a commercial practice context. The reason that we chose a commercial valuation practice was that the valuation of a commercial property is invariably complex, involving considerable judgment that requires the valuer to gather and integrate a large amount of information from multiple knowledge domains (Havard, 2001a; 2001b). Thus, the context of the task could be characterised as fulfilling Simon's (1973) criteria of a highly ill-structured problem, which makes it an interesting focus for research on valuers' thinking and decision-making processes. The task was designed in the form of a typical valuation case requiring the valuation of a warehouse property located in a city (Birmingham, UK). Such a valuation case was familiar to all the participants – a feature that makes the task an authentic valuation similar to that a valuer might encounter in practice. The practicality and authenticity of the task was further enhanced by using a task that was developed from a real valuation report produced by a chartered commercial valuer but obtained from the property owner, whose permission was sought for the information to be used for the purpose of this research.

The valuation task required participants to prepare a valuation of an industrial/warehouse property located in Nechells, Birmingham. The purpose of the valuation was to assess the market value of a long-leasehold interest of the property for sale. The freehold of the property is owned by Birmingham City Council and is presently held by the client on a ground lease for a term of 125 years from 25th December 1989. The property comprises of a two-storey detached warehouse of concrete frame construction with brick infill elevations under part flat roof/part pitched asbestos-clad roof on steel trusses. At the time of inspection, the property shows signs of wear and tear to be expected of a building of this age – constructed in the 70s. It has evidently been vacant for some time and accordingly has suffered from acts of vandalism and roof leaks and is in extremely poor decorative order. Also, there is a substantial crack in the rear corner of the ground floor brick wall which has been poorly repaired. Overall, the property requires complete refurbishment. The rationale for using a property in such a dilapidated state was to ensure that participants are dealing with a complex valuation case that requires them to solve multiple problems in the course of assessing the market value of the property.

The task was set out in an information pack of approximately 1,300 words. The information pack was sent to all participants a day in advance of them undertaking the valuation. Our focus was on designing a task that captured the real-world valuation environment where the valuer will normally undertake an inspection of the property and obtain relevant property and market data before preparing the valuation.

While this guarantees a high ecological validity, one disadvantage of this choice is that the study does not provide any data about de Groot's "first phase".

The information pack consisted of narrative statements for valuation instructions, description of the subject property, comparable sales and lettings data, and other related information which resulted from a diligent inspection of the property and a search of the market. Photographs were also provided to improve visual content. This simulated valuation task was comparable to a "fixed-order" problem where expertise differences in thinking can be revealed by having participants respond to identical case data (Elstein et al., 1978). Also, the task was evaluated in a pilot session with a valuer with over 20 years of valuation practice experience to ensure that it reflected a typical valuation task that a valuer might encounter in practice. Required revisions such as including additional information or clarifications were made after the trial session to enhance the realism of the exercise.

Data Analysis

The participants' verbal protocols were analysed using content analysis (LeCompte et al., 1993; Patton, 2002) and Ericsson and Simon's (1984) method for protocol analysis, which includes three phases of analysis, as described below.

(a) Transcribing and segmenting the verbal protocols

The audiotapes of the participants' verbal reports were transcribed and then broken down into small units or segments. Ericsson and Simon (1984) refer to these segments as 'statements', each representing a single thought or process. There are two alternative ways to segment verbal protocols: segmenting based on complete ideas or segmenting based on a set of time interval (Ericsson & Simon, 1984). In the present study, the transcripts of participating valuers were segmented in accordance to a complete thought or to clear changes in topic. This way, each segment could address a particular instance of problem-solving behaviour on the task or relate to a "single production activity" (Ericsson & Simon, 1984, p. 207). This method also allows the usual convention of assigning each segment a single code (Ericsson & Simon, 1984; Yang, 2003). The option of segmenting based on a set of time intervals was used in several studies of the problem-solving strategies in engineering design (e.g., Ball et al., 1997; Motte et al., 2004) but was not considered appropriate for this research as some segments might contain more than one category of cognitive activity.

(b) Encoding the verbal protocols

The coding scheme used in the present study was based on a preliminary analysis of the protocol content as well as previous schemes developed by Hassebrock and Prietula (1992) in their analysis of medical problem solving. It was also similar to other schemes for coding human problem solving activity found in the literature (Ericsson & Simon, 1984; Greeno & Simon, 1988; Newell & Simon, 1972) but differed

in the extent to which it contains valuation-specific terminology. The scheme was used in the present study because it has been applied in several other domains such as mammographic interpretation (Azevedo et al., 2007). This, therefore, allows a direct comparison of task analysis with other domains of expertise. The coding scheme is based on two types of protocol representation: (a) knowledge states and (b) problem-solving operators (Hassebrock & Prietula, 1992; Newell & Simon, 1972). These two major categories and their subcategories are presented in Figure 1. In the process of coding the protocols, operational definitions along with examples were also formulated for each category (see Appendix A and B).

(c) Analysing and interpreting the codes

The participants' verbal protocols were analysed in two stages. In the first stage, the analysis set out to reveal the cognitive processes underlying a commercial-valuation problem solving through a deductive coding of protocols in accordance with the problem-based coding scheme presented above. First, the knowledge states contained in the transcripts were underlined and coded. The process of coding was to look for and underline the main clause or noun phrase in each segment directly on the transcript. These were then coded depending on whether they pertained to the instruction, valuation information or self-generated ideas or solutions. For example, segment 124 of EV1 protocols *"What I then need to consider is what adjustment to make with the condition"* involves a qualifier "What I then need to consider is" to the main clause (underlined) which refers to a procedure within the valuation process and is coded as "Technique–adjustment to valuation opinion". Second, each knowledge state identified is then associated with one of the possible problem-solving operators which represent discrete problem-solving segments of undertaking commercial property valuation. For instance, in our earlier example, the qualifier appears to signal the tentative nature of the cognitive act being undertaken in regard to the knowledge state "Technique–adjustment to valuation opinion" which, in this case, is a control process indicating an intended action. Based on this, the segment was then coded "Meta-reasoning; plan" to reflect the main and specific problem-solving operators that have been used to modify the knowledge state within the segment. A sample of protocol episode from EV1 transcript and the coding for knowledge states and problem-solving operator is shown below.

	Protocol Segment	*Knowledge State*	*Problem Solving Operator*
124	*What I then need to consider is what <u>adjustment to make with the condition</u>*	*Technique - Adjustment to valuation opinion*	*Meta-reasoning: plan*
125	*The condition is said to be vandalized and fairly poor and there is structural crack at the back*	*Physical attribute: condition of property*	*Summarization: repeat-data*

126	*So I think I am being inclined to start looking at this as the benchmark and adjust downward a little bit to make some sort of adjustment for that condition really*	*Technique - Adjusting downward to reflect condition*	*Meta-reasoning: plan*

In the second stage, a detailed interpretation was undertaken both quantitatively and qualitatively; the quantitative interpretation focused on the frequency of use of different cognitive activities that were identified in the participants' verbal protocols while the qualitative interpretation focused on how participants used each category of the cognitive activities identified as well as a broader interpretation of the way they deal with the commercial valuation task. Additionally, an event-sequence analysis was undertaken to reveal the valuers' pattern of thought. This was done through Jeong's (2005) Discussion Analysis Tool. This tool, originally developed for analysing interactions of individuals in computer-mediated communication, was used to generate transitional state diagrams from the participants' verbal protocols.

Findings and Discussion

A summary of valuation analysis times (in minutes), number of segments and case references per participant is shown in Table 2. A number of interesting observations emerge from these data. First, intermediate valuers' analyses were generally longer than those of the experts and novices. This difference in analysis time is surprising and may suggest the existence of an intermediate effect in valuation case analysis. It also shows that the presence of extensive knowledge does not make expert analysis necessarily slower. Second, even though all participants were provided case materials in advance, they still looked back at the case data from time to time during the valuation analysis. The number of case references were calculated by counting the number of valuation relevant data segments from the protocol reports that were directly recalled from the given valuation case, omitting repetitions. On average, the results show that experts and intermediates did not differ substantially in the amount of case data they recalled.

Knowledge States Used during the Valuation Task

The knowledge state is a type of protocol representation (Newell & Simon, 1972) which, in our case, identifies units of knowledge used by valuers in assessing a commercial property. This included their knowledge of theory and application of valuation concepts, procedures and methods, which allows them to analyse the physical, legal, geographical, environmental and market information that is relevant to the type of property being valued and provide explanations or solutions to valuation problems. The knowledge state identified by participants was classified into three broad categories: data analysis,

technique and self-generated ideas. Data analysis and self-generated ideas were adapted from the two general categories of knowledge states presented in Hassebrock and Prietula's study (1992). However, a third category – technique – was included to capture instances where a valuer refers to valuation theory, methods, principles and procedures. Table 3 contains a summary of the results of the analysis of the use of the knowledge states as well as the number of times that the participant used them.

The results demonstrate that, similarly to the study of expertise in other subject domains, the content and organisation of knowledge states used in a commercial property valuation task are significant in differentiating different levels of valuation expertise. The analysis revealed that the expert and intermediate valuers shared a fairly similar frequency of use of instances of knowledge states that they managed to generate during the valuation task, and that both generated and used instances of knowledge states more frequently than the novice valuers. A total of just over 190 instances of knowledge states were referred to by the expert and intermediate valuers, while the novice valuers referred to only 56. This clearly showed that both expert and intermediate valuers, given the practice and experience they have had, are more comprehensive in analysing the valuation instruction.

Therefore, it could be inferred that the expert and intermediate valuers were rapidly able to develop a rich mental framework to integrate their knowledge with the circumstances of a specific property and the comparable information attributes, and to anticipate potential consequences through the conceptual operations they had utilised to carry out their valuation analysis within a short period of time. Consistent with other domains of expertise such as writing assessment (Barkaoui, 2007; Condon, 2009), this could be largely attributable to their practice, experience and a collection of conceptual and procedural knowledge types that they have developed over time. It thus suggests, as argued by Hassebrock and Prietula (1992), that experts are better at rapidly recognising patterns of knowledge states to augment the problem-solving operators utilised during the valuation problem solving task.

The results of the analysis further demonstrated that expert and intermediate valuers evaluated/analysed the task more thoroughly than the novices – roughly three times as much. In particular, expert valuers carried out different levels of data interpretation which focused on instruction, subject property characteristics and comparable evidence (altogether a frequency of 64 times). This is consistent with other domains of expertise, such as mathematical problem solving (Schoenfeld, 1992) and engineering design (Ball et al., 1997), where the amount of evaluation has been established as an indicator of expertise. Expert and intermediate valuers did not only evaluate more than the novices, they did so with more and better evaluative criteria. In particular, they were more likely to return to the valuation instruction statement to re-evaluate their analysis against standard criteria or given facts. They were also more likely to question the information in the valuation instruction and as such were more critical than the novices. This clearly demonstrated the nature of expert and intermediate valuers' analytical

approach, which appears to rely heavily on schema-based knowledge. The ideas that novices generated were mainly derived from the facts presented in the valuation instruction (i.e., primarily driven by text-based knowledge).

	Seg. No	*Segment Text*	*Knowledge State*	*Problem Solving Operators*
EV 1	*106*	*But the method that I would kind of like to do is to then kind of take off is on the traditional sort of valuation of taking a rental value of £21,000, take off the current ground rental of 3750*	*Technique - Leasehold capitalisation*	*Meta-reasoning: plan*
EV 1	*107*	*Again, there is a bit of caution that, not sure if there is reversionary or not*	*Property analysis*	*Meta-reasoning: self-evaluation*
EV 1	*108*	*But if I just kind of assume that the 3750 would be okay,*	*Property analysis*	*Meta-reasoning: self-evaluation*
EV 1	*109*	*that would give a profit rent of 17,250, I think,*	*Technique - Profit rent*	*Data-exploration: apply*
EV 1	*110*	*which are then capitalized at YP at an appropriate yield*	*Technique – Capitalisation*	*Meta-reasoning: plan*
	-	*-*	*-*	*-*
EV 1	*112*	*Traditionally, I would like to kind of do that with the dual rate approach and,*	*Technique - Dual rate capitalisation*	*Meta-reasoning: plan*
EV 1	*113*	*actually, I think that, probably wouldn't make much of a difference mathematically*	*Technique - Dual rate capitalisation*	*Meta-reasoning: self-evaluation*
EV 1	*114*	*So there is room we might do it as a single rate.*	*Technique - Single rate capitalisation*	*Meta-reasoning: plan*
EV 1	*115*	*because at such an unexpired term it wouldn't actually make much of a difference*	*Technique - Single rate capitalisation*	*Meta-reasoning: cue-diagnosticity*
EV 1	*116*	*But I would, probably, just dive into my current parry valuation table and come up with a YP*	*Technique - Reading Parry Table for YP*	*Meta-reasoning: plan*
	-	*-*	*-*	*-*
EV 1	*119*	*But that would then lead me down to, you know that sort of valuation if I just ignore the kind of advantage of a single rate and do it into perpetuity*	*Technique - Capitalisation in perpetuity*	*Meta-reasoning: plan*

EV 1	*120*	*8.3333 times 17250, that would give me about 145,000*	*Technique - Capital value*	*Data-exploration: apply*

Further inspection of Table 3 reveals that both the expert and intermediate valuers were more likely to generate their own ideas, based on knowledge and assumptions external to the valuation task, than the novice valuers who tended to focus more on the contents of the instruction pack provided to the exclusion of other knowledge states. This, in essence, means that both the expert and intermediate valuers were more creative while novices appear shallow in their generating of ideas. Perhaps more importantly, the results also suggest, as in most domains such as physics (Larkin, 1981; Simon & Simon, 1978) and mathematics (Suto & Greatorex, 2008), that expert and intermediate valuers have greater and better organised knowledge that facilitate problem recognition and solutions to the problem. Novices, on the other hand, lack the organisation of a schema and this accounted for their limited recognition of knowledge states.

In terms of knowledge states relating to valuation technique, a detailed inspection of the verbal protocols revealed that while the intermediate valuers appear to have referred to instances of these knowledge states more than the expert and novice valuers, expert valuers' use of valuation concepts and methods was richer because it also identified the strength and weaknesses of techniques. The following section provides an instance of this, where Expert valuer 1 engaged in the generation, application and self-evaluation of valuation concepts, methods and procedures.

Problem Solving Operators Used to Represent Knowledge States

Problem-solving operators are the inferred cognitive processes that modify an existing active knowledge state or produce a new active knowledge state (e.g., Hassebrock & Prietula, 1992; Newell & Simon, 1972). Each segment of the verbal protocols produced by the valuers comprises one or more knowledge states and a problem-solving operator that produces or modifies the associated knowledge state or states. A summary of the frequency of participants' use of problem-solving operators during the conduct of the valuation task is provided in Table 4 below.

The quantitative analysis presented in Table 4 showed that the expert valuers used more different types of problem-solving operators (18 types) than the intermediate and novice valuers who had used 14 and 10 types of problem-solving operators, respectively. The analysis further showed that while there were no overall differences between expert and intermediate valuers in term of frequency of use (223 and 209 times, respectively), the novice valuers recorded far more fewer instances of problem-solving operators (66 times). Therefore, it could be inferred that both expert and intermediate valuers had a rich and organised pattern of thought to represent the problem (Hassebrock & Prietula, 1992). The

results presented in Table 3 clearly show that the expert and intermediate valuers had used more varied problem-solving operators as they exploit their knowledge to provide a deeper and richer interpretation of property and market information provided in the valuation instruction. As a result, they were able to provide quality valuation analyses.

In terms of how these problem-solving operators were used, a number of interesting qualitative differences were observed from the detailed examination of the verbal protocol data.

First, both expert and intermediate valuers were generally more rigorous in their reading of the valuation case than the novice valuers. The same applies to the problem-solving operator "Examine", which was used to selectively identify and form initial interpretations of specific property or comparable attribute(s) from the particular set of instructional data. Through the problem-solving operator "Examine", the valuers would, for instance, interpret the quality of an information attribute by either comparing it to what is usually the norm, to another cue or by stating the degree of abnormality as illustrated in the previous sub-section. The fact that both expert and intermediate valuers appear to have used these problem-solving operators could suggest that they had broader knowledge of criteria for making judgments and decisions in regards to the reliability of valuation and comparable data than the novice valuers.

Second, analysis of the data exploration procedures revealed that the intermediate valuers were more likely to use the problem-solving operator "Apply" than expert and novice valuers when performing commercial property valuation. As set out in Table 3, intermediate valuers used this operator about 30 times which is far more than the experienced and novice valuers did. This is not surprising and seems to emphasise the natural role of graduate surveyors who are still undergoing professional training in practice. A further analysis of the participants' verbal protocol revealed that they all used the problem-solving operator "Apply" mainly to determine the unit of comparison (rent per square metre or square foot) for further examination and also to work out the rental value and yield applicable to the subject property. In addition, the problem-solving operator "Apply" was used to carry out a procedure involving application of valuation technique. Analysis of the participants' verbal protocol transcript revealed that they all used the operator to determine the leasehold unexpired tenure and profit rent which is then capitalized at appropriate yield. The fact that expert valuers did not engage in considerable application of valuation procedures and methods could be evidence of automaticity in the valuation process. Other types of data exploration operators that were identified from the verbal protocol transcripts are "Search" and "Note absence of data". Again, there were quantitative and qualitative differences between the participants in the use of these operators. For instance, novice valuers could not identify missing information in the instruction. Also, the expert and intermediate valuers are more likely to elaborate when searching than novices. For example, intermediate valuer 1 note:

	Seg. No	*Segment Text*	*Knowledge State*	*Problem Solving Operators*
IV 1	*67*	*We need to know some details about any leases or in place for comparable 4. If it sold with vacant possession or whether it is sold with tenant in situ?*	*Comparable evidence - Details of lease on comparable 4*	*Data-exploration: search*

In searching for the lease details of comparable 4, Intermediate valuer 1 went further to suggest two options relating to what is usually the case when a property is sold. The knowledge that he used to make this suggestion is not directly attributable to anything that is provided in the instruction data. Similarly, at segment 86, Expert valuer 1 raised concern about lack of adequate information on comparable 2 and 3. He then asked a leading question about the floor distribution of the two comparable which could be attributable to the activation of a knowledge structure that provided Expert valuer 1 with a template of normal pattern of value distribution in regards to different floor areas.

	Seg. No	*Segment Text*	*Knowledge State*	*Problem Solving Operators*
EV 1	*86*	*I am just… the sort of concern I have with those two comparable that there is not quite enough information there, whether the floor area is equally distributed between the two floors or whether the first floor is much smaller and so on*	*Comparable evidence - Comparable floor distribution*	*Data-exploration: search*
EV 1	*87*	*Because, generally we would expect the first floor to be much less valuable than the ground floor accommodation.*	*Recall - Normal pattern of value distribution*	*Meta-reasoning: experiential-memory*

In contrast to expert and intermediate valuers, novice valuers' searches contained inferences that could have easily been made based on the information provided in the valuation instruction. For example, Novice Valuer 1 asked at segment 11 'how long was the property not occupied?'. As this question was followed by a statement from the instructional data (segment 12) that the property 'has been in the market for the past two years', it is not an elaboration.

Third, the results presented in Table 4 revealed some differences in the use of meta-reasoning operators of "Plan", "Experiential memory", "Cue-diagnosticity" and "Self-evaluation". The data collected for this research suggested that valuers used these meta-reasoning related operators to evaluate the reasoning process during the verbalisation of the given valuation task. In particular, the valuers used

statements of plans to indicate intended action or schedule an activity, cue-diagnosticity to make a general comment about possible explanations of a case and experiential memory to recall relevant information or previous valuation cases to justify their comments. The following data extracts provide examples.

	Seg. No	*Segment Text*	*Knowledge State*	*Problem Solving Operators*
EV 1	57	Then again, can I just kind of look at the comparable sales and letting evidence.	Comparable analysis	Meta-reasoning: plan
EV 1	58	I mean there are several comments really.	Comparable evidence	Meta-reasoning: cue-diagnosticity
EV 1	59	The subject property was the top line comparable, has limited use	Subject property has limited use	Data-examination: determine-severity
EV 1	86	I am just… the sort of concern I have with those two comparable that there is not quite enough information there, whether the floor area is equally distributed between the two floors or whether the first floor is much smaller and so on	Comparable 2 & 3 floor distribution	Data-exploration: search
EV 1	87	Because, generally we would expect the first floor to be much less valuable than the ground floor accommodation.	Normal pattern of value distribution	Meta-reasoning: experiential-memory
EV 1	88	That is normal unless you get a kind of very restricted height on the ground floor and better space on the first floor or something like that	Exception to normal pattern of value distribution	Meta-reasoning: experiential-memory
EV 2	8	You've told me that we assume that it wasn't made of deleterious materials on site although I did note under the construction details it does have asbestos	Presence of asbestos	Discrepancy-processing: recognition
EV 2	9	and a property of that age would naturally have asbestos	Natural presence of asbestos with age	Discrepancy-processing: resolution: system-thinking
EV 2	11	which I'd expect to see the asbestos register.	Inspection of asbestos register	Meta-reasoning: plan
EV 2	24	There is sign of the cracking in the back wall	Repair and condition	Data-examination: read

EV 2	25	but that wouldn't be uncommon with buildings of this nature just particularly with heavy industrial use	Common cracking condition with heavy industrial use	Meta-reasoning: experiential-memory
EV 2	26	I would think there's probably a lot of damp in the main structure of the building	Lot of damp in the main structure	Data-explanation: infer
IV 1	91	So is difficult to, I will normally put the term and reversion on a leasehold valuation, value the term up to the next reviews and value the reversion at the current market rent	Leasehold valuation approach	Meta-reasoning: plan
IV 1	92	But we don't know what the market rent should be	Market ground rent	Meta-reasoning: self-evaluation
IV 1	93	In my experience of valuation, which suggests the rent is about £7 a square metre for a ground rent	Market ground rent	Meta-reasoning: experiential-memory
IV 1	107	For a leasehold interest, well we probably need to add a bit on there for the yield. Glad on 2% for the yield for leasehold interest	Adjustment to freehold yield	Meta-reasoning: plan
IV 1	108	As I understand, the higher the yield, the more generally you have to make an adjustment	Rules for adjusting yield	Meta-reasoning: experiential-memory
IV 2	71	Alright I was thinking of a yield...the market at the moment is anywhere between 8 and 10	Present yield applicable to subject property	Meta-reasoning: experiential-memory
IV 2	72	the one I have in Northampton Robin was office property that is not really a useful one plus 8%,	Office yield from Northampton	Meta-reasoning: cue-diagnosticity
IV 2	73	...okay let's have a look yield 13% but is going to be high because you are losing 3750 you are paying that to the Council every year, just taking a chuck out of your income so you are not going to be getting low yield...	13% yield	Meta-reasoning: self-evaluation

While there appear to be no consistent differences between the use of these meta-reasoning operators by the expert valuers, on the one hand, and the intermediate valuers, on the other, the incidence of use seemed very low for novice valuers. Also, novice valuers did not generate any recall during the verbalisation of the valuation task, suggesting that they did not have enough relevant knowledge and experience to guide them in the valuation.

Finally, as is clear from the examples above, there are several instances where intermediate and expert valuers seem to engage in intuition. No evidence of intuition was found in novices' verbal protocols.

Mapping of Valuers' Thought Processes

The problem-solving operators for each participant group were further organised in sequential order to distinguish the pattern of thought between the three groups of valuers. Figures 2, 3 and 4 display expert, intermediate and novice valuers', respectively, transitional state diagrams used in analysing patterns of reasoning during performance of the commercial valuation task. These transitional state diagrams were obtained through Jeong's (2005) Discussion Analysis Tool. Nodes represent the research's categories of problem-solving operators and the varying sizes of shadow/glow reflect the node's frequency. The arrows linking these nodes represent the direction and strength of the interactions between the problem-solving operators; the lines are coloured grey if the probability is not significantly higher than expected. Jeong's (2005) Discussion Analysis Tool utilises z-scores to identify the probabilities that are higher/lower than expected. The numbers in the diagrams represent the percentage of one category of problem-solving operator being followed by another. For instance, in Figure 2, the percentage of hypothesis-related operators being followed by data-exploration operators is 25%.

The patterns of sequences of thought of expert valuers (see Figure 2) suggest that they engaged in data interpretation (i.e. data examination and data exploration). That is, 34% of segments of their protocols were categorised as either data examination (24%) or data exploration (10%). In addition, 43% of the segments concerned evaluation of their reasoning process (i.e. meta-reasoning). Meta-reasoning related operators are likely to follow expert valuers' data examination or exploration (39% and 55%, respectively). Once engaged in meta-reasoning related operators, they are likely to spend more time in this process (54%); they also tend to revisit the data they had considered earlier either for further examination (23%) or exploration (10%). Data explanation was mainly preceded by data examination and more likely to be followed by meta-reasoning (36%) or re-examination of data (36%). During the valuation exercise, expert valuers also relied on self-generated ideas in the form of hypothesis (8%) which are more likely to be followed by operators of the same category (25%) or justified through meta-cognition (19%) and examination or exploration of selected data cue (19% and 25%, respectively).

The patterns of sequences of thought of intermediate valuers (see Figure 3) were centred on interpreting data and meta-reasoning. 40% of segments of their protocols were categorised as data examination (17%) and data exploration (23%). Evaluating their reasoning process (i.e., meta-reasoning) comprised 45% of the segments. The intermediate valuers appear to have spent more time interpreting data than the expert valuers. However, once they have examined or explored the data in full, they were more likely to follow this by meta-reasoning operators (33% and 48%, respectively), just like the experts.

Similarly to the expert valuers, the intermediate valuers used hypothesis operators to generate ideas/solution to challenging valuation problems and are more likely to follow this by meta-reasoning (43%) or exploration of data (29%) in support of their ideas/solutions. Overall, data explanation was rarely used (percentage was based on only four protocol segments) but was mainly preceded by data examination (7%) and more likely to be followed by meta- reasoning (50%), re-examination of data (25%) or further exploration of data (25%) to justify their explanations. Contrary to experts, intermediates produced some summarisation statements.

The patterns of sequences of thought of novice valuers (see Figure 4) were centred on data interpretation and evaluation of reasoning process; also, hypothesis generation was rarely used. Contrary to both expert and intermediate valuers, more than 50% of their verbal protocols were categorised as data examination and exploration. Once engaged in data examination or data exploration, novices tend to stay in the process (41% and 38%, respectively) or to follow their examination or exploration with meta-reasoning (36% and 31%, respectively). Similarly to the intermediate valuers, the novice valuers rarely use data-explanation operators (the percentage was based on only four protocol segments), which are exclusively preceded by data examination and likely to be followed by meta-reasoning (25%), re-examination of data (50%) or further exploration of data (25%) to justify their explanations. Note that the novices spend a considerable amount of time in meta-reasoning (50%).

Overall, the analyses presented above suggest that both expert and intermediate valuers had structured thought-processes which demonstrate more cohesiveness and interrelatedness between problem-solving activities. These findings are consistent with previous studies that have investigated expert-novice differences in terms of their cognitive structures (e.g., Chi & Koeske, 1983; Le Maistre, 1998; Perez et al., 1995; Villachica et al., 2001). For instance, Perez et al. (1995) argued that one of the fundamental differences between expert and novice instructional designers was the structure of the understanding they demonstrated in relation to the design problem they were asked to solve. Expert designers established more complex interconnectedness between entities of the problem as compared to novices who had few linkages. The present research confirmed that novice valuers' structured processes of solving the valuation problem showed fewer linkages between problem-solving operators, which may suggest underdeveloped cognitive structure or quick disengagement from the task.

The analysis presented above also revealed that both the expert and intermediate valuers used meta-reasoning a great deal in their valuation analysis. This facilitates the process of planning strategies and goals for the valuation, and makes it possible to conduct it in a more-efficient way, as specific relevant property and market information could be easily identified and diagnosed, and the solutions generated during the valuation analysis could be evaluated and summarised more effectively. The novice valuers, on the other hand, constructed a representation of the valuation task in a slow, step-by-step manner

which failed to explore the valuation in any depth after interpretation of some selected data cues in the instruction. The relative absence of meta-reasoning among novice valuers in the valuation analysis compares with other expertise domains such as engineering design (Ball et al., 1997). In addition, the results of the analysis indicate that, although expert, intermediate and novice valuers show a pattern of thought revolving around data interpretation and meta-reasoning activities, expert valuers spent more time than the intermediate and novice valuers did on the latter, scheduling valuation analysis or establishing valuation strategies, diagnosing previously acquired information to update the outcomes of their past valuation problem solving. These findings are also consistent with findings of Amidu et al.'s (2019b) recent study, which have established that meta-reasoning allows expert valuers to maintain a subtle balance of theory and experience in valuation practice that is appropriate to the situation. Thus, it is important that pre- and post-registration professional valuation education encourages a robust discussion of the roles of meta-reasoning skills in decision making and how these might be developed in the didactic learning setting. Although property professional organisations such as the RICS emphasise metacognitive skills and related skills in critical thinking in their education accreditation standards, evidence of formal teaching of these skills are scarce and this further reinforces the need to consider explicit teaching of metacognitive skills in professional training.

In their exploration of data, expert valuers often did not engage considerably in applying valuation procedures and techniques, suggesting a high degree of automaticity during the performance of a valuation task. This is not surprising as experts usually rely on automatic processes during performance of well-learned skills, using procedural knowledge that does not require attention nor monitoring (Beilock & Carr, 2001). By contrast, novices rely on a step-by-step approach to performing the task, during which they use declarative knowledge held in short-term memory to monitor poorly learned skills.

Although the results of the event-sequence analysis presented in this section provide useful insights on valuers' pattern of thoughts in valuation problem solving, the transitional state diagrams represent only the problem-solving operators deployed in the valuation task. It was, therefore, necessary to develop a more unified model which integrates the three semantic elements (knowledge states, problem-solving operators and strategies) in order to provide a deeper understanding of how valuers address the valuation task.

A Descriptive Model of Expert Valuer Cognitive Structure

A cognitive structure, in the context of this study, is a functional abstraction of the commercial valuation task given to the valuers which provides a deductive framework of cognitive activities for carrying out commercial valuation. The descriptive model of expert-valuer cognitive structure was developed using a synthesis of the results related to the valuers' construction of problem and solutions and their use of

problem-solving operators to generate knowledge states. The model is hypothesised to be a qualitative description of how an expert valuer cognitively carries out commercial valuations; it entails and integrates knowledge states, problem-solving operators and strategies used to analyse and interpret data and to make market inferences. The expert valuer's model of cognitive structure developed from this study is shown in Figure 5.

The intermediate and novice valuers' models follow the same structure but differ in terms of the emphasis given to the use of knowledge states and problem-solving operators during the valuation process. The expert model developed in this study is also a problem representation of undertaking a commercial valuation task. This, according to Newell and Simon (1972), enables a problem solver to actively acquire information, make inferences, anticipate solutions and develop plans for future decision making. These processes were embedded in the problem-solving behaviours of valuers as they make use of various problem solving operators and strategies while integrating their prior knowledge states with relevant data cue to conduct a commercial-valuation task effectively.

The model presented in this study shows that, where available data is inadequate, valuers solve a valuation problem by dividing the problem into a number of sub-problems that are solved by engaging in two main types of thinking: analytical and intuitive thinking. Analytical thinking involves sequential processes of acquiring information, evaluating the information and specifying further analysis or searching for more information. At this level, the valuers' aim is to provide detailed interpretation of the valuation instruction alongside property specific and comparable evidence in order to identify problem attributes and to choose which comparable property was best to use to infer market price. Intuitive thinking, on the other hand, involves the process of rapidly developing and evaluating solutions. These two processes continue in successive interactions until the valuer has reached a valuation opinion. In addition, they are preceded by an established goal, which, at the initial stage of carrying out the valuation, might be to determine whether there are inconsistencies in the information provided.

This interaction between intuition and analytical thinking supports Gobet's (1997) model but is inconsistent with theories emphasising intuition at the exclusion of analytical thinking, theories emphasising analytical thinking at the exclusion of intuition, and theories proposing that a first intuitive phase is followed by a second analytical phase where intuition is absent. It can be seen as necessary for expertise and what needs to be encouraged in novices for them to develop. Some other scholars have strongly advocated for an integrative approach to decision making (e.g., Elbanna, 2006; Langley et al., 1995). The results of this study suggest that such integration can occur in the operation of meta-reasoning which involves challenging the available data and a continual exploration of alternative reasoning for the apparent situation. Thus, it is argued that intuitive approaches can be effectively

integrated within a rational framework to decision making, thus allowing a decision maker the benefit of both approaches. Such integration also concurs with the cognitive psychology's dual process view on information processing (Evans, 2003; Sloman, 1996; 2002). However, unlike in this tradition where intuition is perceived as subservient to analytical thinking, the findings of this study suggest more balanced integration where both mechanisms share equal importance in making effective decisions. In this context, it is critical for organizations employing professionals to consider ways through which the interplay between intuition and rationality might be understood as complimentary components of effective professional performance.

In terms of differences between participants, the model shows that, while engaging in the analytical thinking process of integrating data with their pre-existing knowledge, both expert and intermediate valuers focused mainly on comparables, followed by subject-property attributes. On the other hand, novice valuers appear to prioritise subject property attributes, followed by comparable evidence, in their interpretation. The problem-solving operators show that both intermediate and novice valuers prioritise data exploration, which includes applying, searching for and noting absence of data.

While engaged in intuitive thinking, the expert model shows that the expert valuers developed more and richer solutions, including self-reference to one's own valuation practice or method, followed by hypothesis generation, recommending further action or investigation, explaining causes or defects, recalling previous valuation cases and resolution of discrepancies or inconsistencies in the information provided. In terms of the problem-solving operators they deployed, the model shows that the priority list of expert valuers includes meta-reasoning, followed by data explanation, hypothesis and discrepancy processing. Apart from discrepancy resolution, the intermediate valuers also developed the same types of solution but in different priority order. The novice model, on the other hand, shows that the valuers prioritised recommending further actions or investigations, followed by self-reference and explanation of causes and defects using meta-reasoning and data-explanation problem-solving operators. They could not recall any previous valuation cases or generate hypothesis like both the expert and intermediate valuers did.

Conclusions and Recommendations

This study has investigated the interplay between intuition and rationality in valuation problem solving and decision making. By applying cognitive theories of information processing and using a very detailed and time-intensive analysis of verbal protocols to identify the cognitive structure of expert valuer during a valuation task, this study makes important theoretical and practical contributions.

First, the research contributes to the wider discourse on expertise by showing that theories based exclusively on intuition or analytical thinking are difficult to reconcile with the behaviour of

professionals in a highly professionalised context of commercial property valuation. In addition, rather than relying on intuition in a first stage and on analytical thinking in a second stage, expert valuers continuously use a combination of intuition and analytical thinking in their practice. This research also contributes to behavioural research into the valuation process by extending to it a phenomenon – that is, the interplay between intuition and rationality in valuation decision making – that has been missing in previous studies. Therefore, rather than assuming property valuation as a predominantly rational process, future behavioural research should be conducted within a theoretical framework that recognises that intuition and rationality are used conjointly and are driving the overall valuation decision-making processes.

The findings of this research also have implication for valuation training and practice. Valuation judgment and decision making are important drivers of accuracy. As a result, valuers are constantly searching for ways to improve their ability to make appropriate decisions. In particular, the increasingly uncontrolled and complexity of the valuation task environment and the need to cope with information ambiguity and intransparent market place require the frequent use of intuition for effective valuation decisions. It is also clear from the results of this study that the ability to reason analytically is not enough to make better decisions in commercial valuation cases. A valuer must be intuitive and, in particular, must develop effective solutions in challenging and problematic situations. This finding will suggest the need for valuation professional organisations, such as the RICS, to formerly acknowledge intuition as an important component of valuation professional competence and skill requirement and to customise professional valuers' training and development programs so that valuers develop appropriate intuitive approaches for effective valuation decision making.

This research has also revealed that, in comparison with novice valuers, expert valuers have rich cognitive structures, which emphasises the need to be highly proficient in meta-reasoning skills in order to be able to transform knowledge, deal with problematic valuation situations, especially when domain knowledge is lacking, and to monitor and evaluate one's reasoning effectively. This finding will suggest that it is meta-reasoning that enables expert valuers to continuously switch between intuition and reason in their practice. This identification of the role of meta-reasoning and the unpacking of how experts utilised it to solve valuation problems can help valuation educators to address the gap in students' cognitive development, which this research has demonstrated through the mapping of the thought patterns of valuers engaged in the valuation task.

In a didactic setting, the teaching of meta-cognitive skills may be achieved through, for example, thinking aloud protocols, cognitive apprenticeships, reflection assignment and self-explanation methods. In the experiential setting, the use of problem-based learning can facilitate a collaborative learning environment where students are able to (re)construct knowledge that is integrated and applied

(Sefton, 2001). This can be achieved by designing a learning environment that creates opportunities for students to actively engage with each other and a valuation task. With this method, learners would be able to develop meta-reasoning skills and problem-solving strategies by interpreting and solving new problems, making plans, linking existing knowledge with new plans, generating ideas and monitoring their own activities. From the results presented in this paper, reviewing other people's valuations and explaining their own derivation of valuations to others can be added to this list.

The study had several limitations that should be addressed in future research. The focus on a very detailed and time-intensive analysis of verbal protocols meant that we had only six participants (two per skill group) and a single problem was given. Thus, replicating the study with a different sample and with several problems would be necessary for confirming the conclusions of this study and ensuring generalisability of the results. As this study focused on commercial valuation decision making, replicating the research in diverse practice settings is also recommended in order to develop models for describing and developing valuation reasoning. In addition, novices spent less time (about one third) on the task than the experts. While such a difference has been reported in the literature when participant face difficult problems (e.g. in writing expertise, Scardamalia & Bereiter, 1991), this has the disadvantage that the number of knowledge states might have been correlated with the length of the protocols.

The primary goal of this study was to gain an initial understanding of how intuitive and rational approaches can complement each other; thus, this study did not explicitly focus on whether intuitive valuation decisions are better than rationally justified ones. As the findings of this study have demonstrated that effective valuation problem solving, based on thorough and comprehensive valuation reasoning, helps experts develop a greater number of more sophisticated solutions to challenging valuation problems than novices, future research could explore how the interactions between intuition and rationality are related to valuation opinions.

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Table 1. Participants' relevant background information at the time of data collection

Code	Academic Qualifications	Professional Membership	Years of Valuation Experience	Average Valuations Per Year
EV1	RICS examinations	FRICS	21 years	1,000
EV2	Bachelor of real estate	MRICS	22 years	350
IV1	Bachelor of real estate	APC candidate	3 years	28
IV2	Bachelor of real estate	APC candidate	2 year	156
NV1	Real estate student	Nil	Nil	Nil
NV2	Real estate student	Nil	Nil	Nil

Note: FRICS = Fellow of the Royal Institution of Chartered Surveyors; MRICS = Member of the Royal Institution of Chartered Surveyors; APC = Assessment of Professional Competence.

Table 2: Time segment and case reference analysis across participant groups

	Novice Valuers		Mean	Intermediate Valuers		Mean	Experienced Valuers		Mean
	NV 1	NV 2		IV 1	IV 2		EV 1	EV 2	
Time (mins)	12	8	10	52	54	53	24	20	22
Segments	38	28	33	133	90	112	129	80	105
Case References	4	2	3	7	11	9	7	12	9.5

Table 3. Summary of knowledge states used by valuers (percentages are shown in parentheses)

Knowledge state	Novice Valuers	Intermediate Valuers	Expert Valuers
Data analysis			
Instruction analysis	2 (4)	0 (0)	9 (5)
Property analysis	11 (20)	25 (13)	18 (10)
Comparable analysis	9 (16)	36 (19)	37 (19)
Sub-Total	22 (39)	61 (32)	64 (33)
Self-generated ideas			
Hypothetical solution	0 (0)	10 (5)	27 (14)
Inferred fact	4 (7)	4 (2)	14 (7)
Resolution	0 (0)	0 (0)	4 (2)
Recommendation	10 (18)	27 (14)	15 (8)
Recall	0 (0)	12 (6)	10 (5)
Self-reference	6 (11)	31 (16)	30 (16)
Sub-Total	20 (36)	84 (43)	100 (52)
Technique	14 (25)	47 (24)	29 (15)
Total	56 (100)	192 (100)	193 (100)

Table 4. Summary of problem-solving operators used by valuers (percentages are shown in parentheses)

Problem-solving operators	Specific operators	Novice Valuer	Intermediate Valuer	Expert Valuer
Data Examination	Read	6 (9)	18 (8)	19 (9)
	Identify	7 (11)	9 (4)	9 (4)
	Examine	9 (14)	11 (5)	22 (11)
Data Exploration	Apply	10 (15)	30 (13)	10 (5)
	Search	3 (5)	15 (7)	7 (3)
	Elaborate	0 (0)	0 (0)	0 (0)
	Note absence data	0 (0)	6 (3)	5 (2)
Data Explanation	Infer	4 (6)	4 (2)	14 (7)
Hypothesis Generation	Trigger	0 (0)	7 (3)	13 (6)
	Further-specification	0 (0)	0 (0)	2 (1)
	Association	0 (0)	0 (0)	2 (1)
	Generalisation	0 (0)	0 (0)	0 (0)
Hypothesis Evaluation	Confirmation	0 (0)	0 (0)	1 (0)
	Disconfirmation	0 (0)	0 (0)	0 (0)
	Discrimination	0 (0)	0 (0)	0 (0)
	Causal relationship	0 (0)	0 (0)	0 (0)
Discrepancy Processing	Recognition	0 (0)	0 (0)	4 (2)
	Resolution	0 (0)	0 (0)	4 (2)
Meta Reasoning	Plan	14 (21)	42 (19)	28 (13)
	Experiential memory	0 (0)	12 (5)	12 (6)
	Cue diagnosticity	6 (9)	15 (7)	21 (10)
	Self-evaluation	6 (9)	31 (14)	30 (14)
Summarisation	Repeat data	1 (2)	20 (9)	6 (3)
	Repeat hypothesis	0 (0)	3 (1)	0 (0)
Total No.		66 (100)	223 (100)	209 (100)

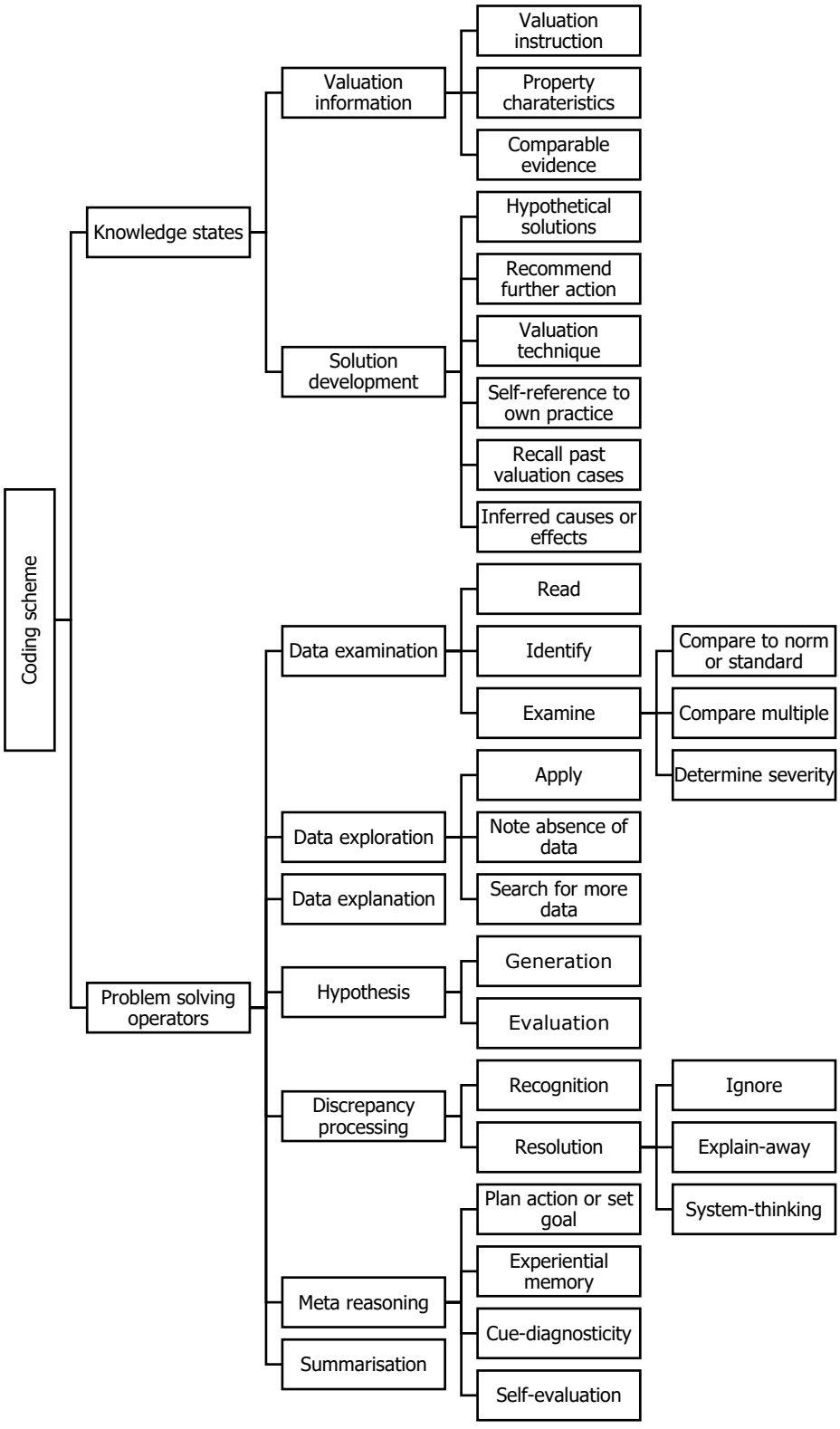

Figure 1. The coding scheme for analysing valuation cognition (adapted from Hassebrock & Prietula, 1992, p. 662)

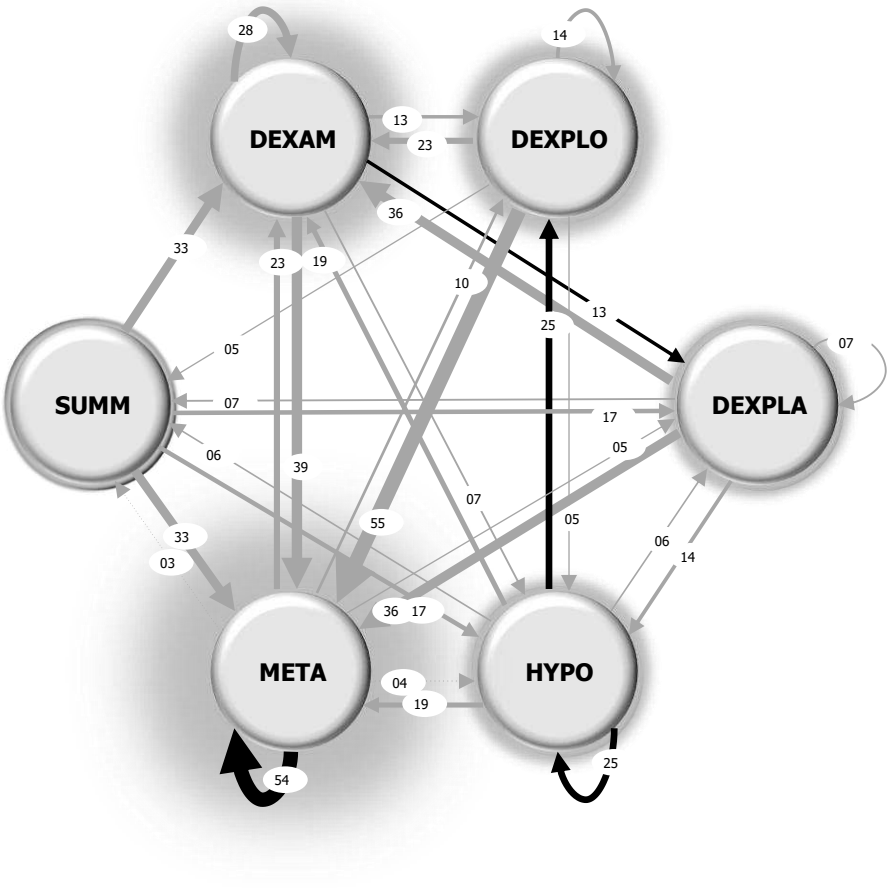

Figure 2. Transitional state diagram of expert valuers' sequential problem solving operators in valuation

DEXAM = Data Examination, DEXPLO = Data Exploration, DEXPLA = Data Explanation, HYPO = Hypothesis, META = Meta Reasoning, SUMM = Summarisation

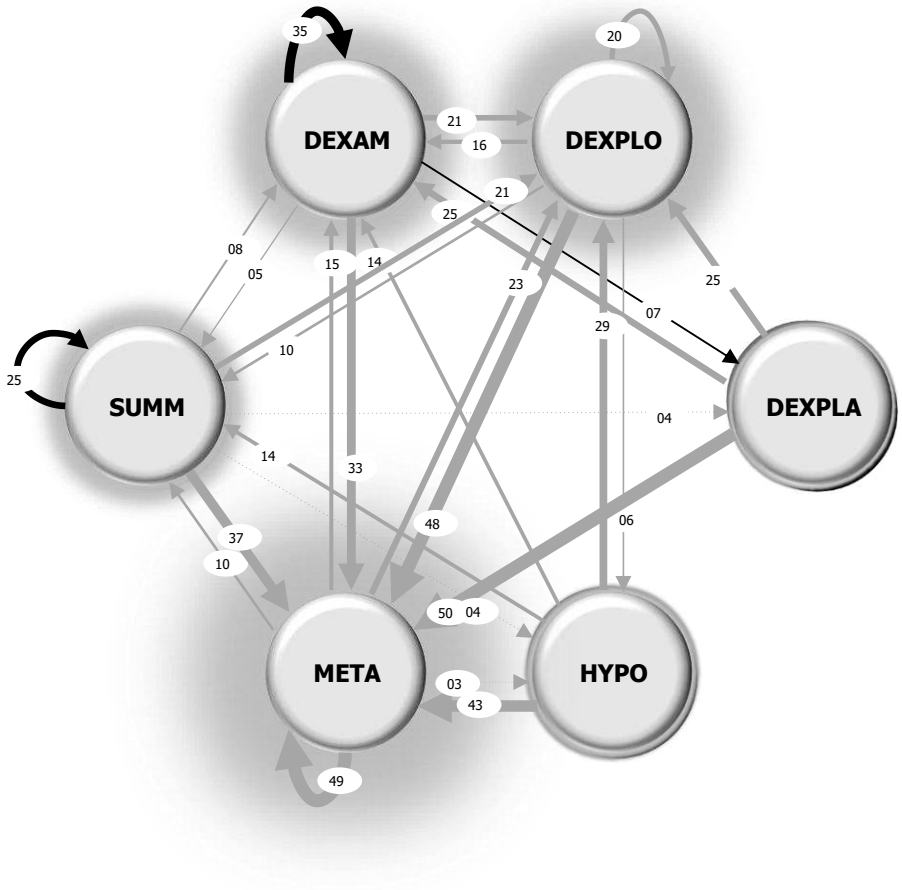

Figure 3. Transitional state diagram of intermediate valuers' sequential problem-solving operators in valuation

DEXAM = Data Examination, DEXPLO = Data Exploration, DEXPLA = Data Explanation, HYPO = Hypothesis, META = Meta Reasoning, SUMM = Summarisation

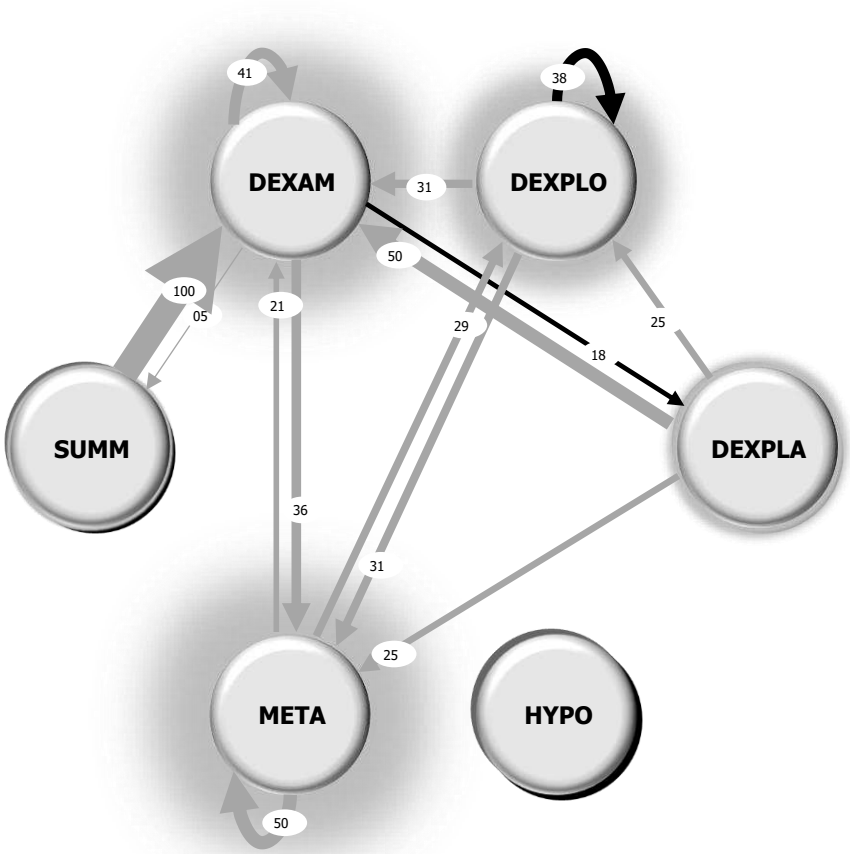

Figure 4. Transitional state diagram of novice valuer sequential problem solving operators in valuation

DEXAM = Data Examination, DEXPLO = Data Exploration, DEXPLA = Data Explanation, HYPO = Hypothesis, META = Meta Reasoning, SUMM = Summarisation

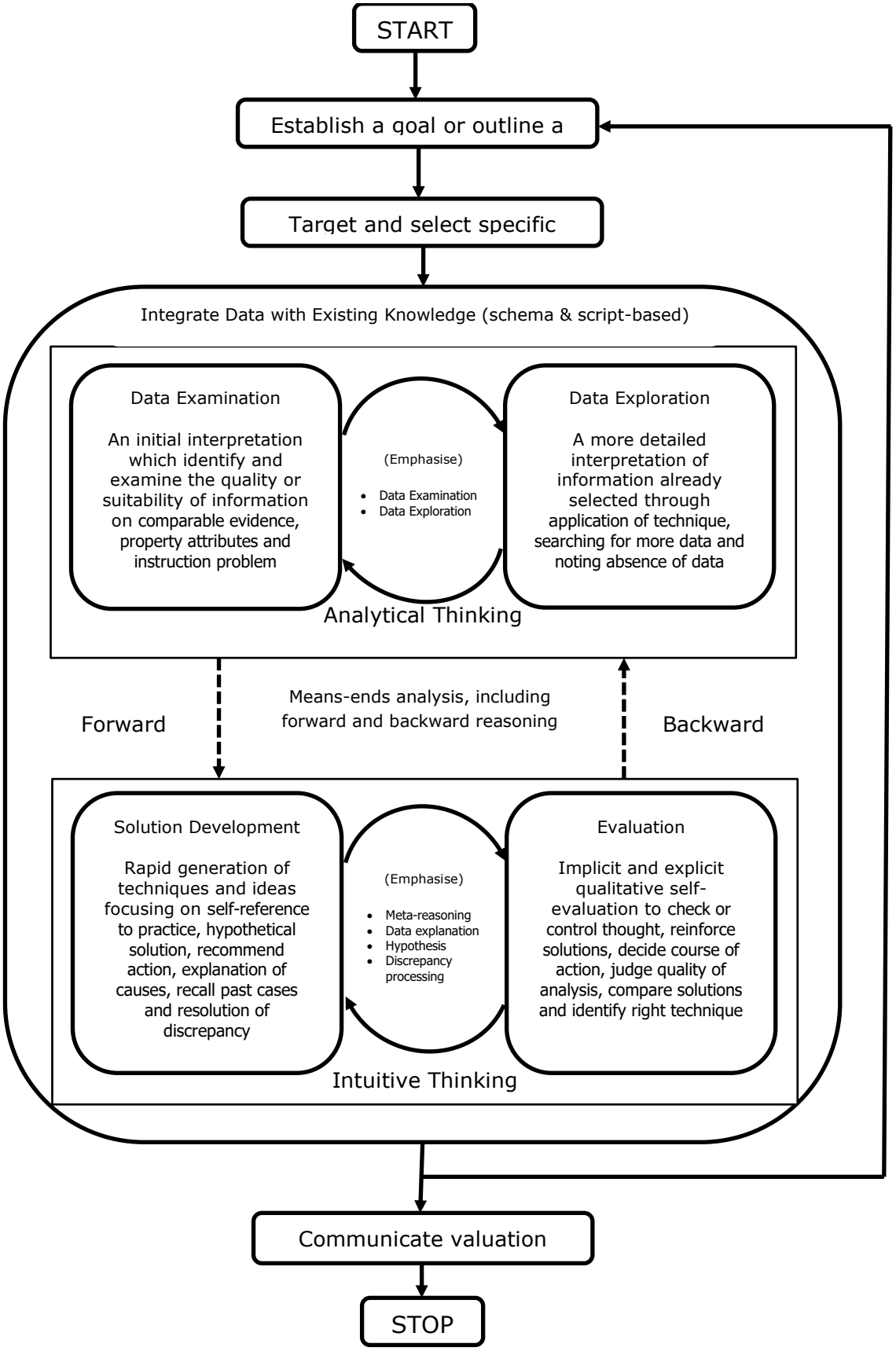

Figure 5. A descriptive model of expert valuer cognitive structure

Appendix A

Codes and operational definitions for self-generated ideas

Self-generated Ideas	Description	Example
Recommendations	A recommendation for further action or investigation	*so possibly we have to, after the full inspection, have to find out what is the total price the developer needs to invest in this building for a full refurbishment to make it in good condition* (NV1: 36)
Inferred fact	Information derived from a previously known fact	*So the crack in rear corner of the ground floor brick wall, well, we will assume that to be non-structural based on the information that has been given (IV1: 136)*
Recalls	Anything explicitly recalled from past experience	*It's an area that is known for lots of industrial activity* (EV2: 57)
Hypothetical solutions	A guess at a solution	*I get the feeling that it is, probably, something like this, you know the yield might be something like 12%* (EV1: 117)
Resolutions	A resolution about discrepancy or about a situation	*So I'd question the areas for starters. Those areas don't make sense to me* (EV2: 38)
Self-references	A reference to self-practice	*I think that I am used to dealing with hectares and square feet* (EV1: 20)
Techniques	References to valuation theory, methods, principles and procedures	*But the method that I would kind of like to do is to then kind of take off is on the traditional sort of valuation of taking a rental value of £21,000, take off the current ground rental of 3750* (EV1: 106)

Appendix B

Codes and operational definitions for problem solving operators

Problem Solving Operators	Specific Operators	Description	Example
Data Examination	Read	Reads verbatim from the instruction and supporting data without generating any protocol	*…and it says evidence of substantial crack in the ground floor rear brick wall which has been poorly repaired* (EV2: 17)
	Identify	Selectively identifies a particular cue from a set of instructional information	*We do know that the subject property has got more than 50 percent worth of offices* (IV1: 23)
	Examine: compare-to-norm, standard or expected	Interpret the significance of a cue using criteria or standard	*Because that give us a surprisingly low site coverage area* (EV1: 10)
	Examine: compare-multiple	Interpret the significance of a cue by comparing it to other cues	*But, I sort of thought that the comparable number 2 is, probably, the most closest and closest in size* (EV1: 89)
	Examine: determine-severity	Interpret the significance of a cue by qualifying further the seriousness of an abnormal finding	*…that crack on the wall can be very dangerous* (NV1: 18)
Data Exploration	Note-absence-data	Note that a particular cue lacks specific information or is not in the instruction data	*But we do not have any information as to what the rent is geared on the rent review basis* (EV2: 4)
	Search	Request, ponder or question the meaning of a specific instruction data	*Okay, so do I need to presume anything on these reviews or is just up to me to decide? is the rent going to increase every 7 years or is it going to stay the same?* (IV2: 9)
	Apply	Carry out or use a procedure, perform calculations	*So 6765 times £23 per square metre…we think the rental value for comparable 4 might be in the region of £155,595, say £156,000, based on £23 a square metre* (IV1: 59)
Data Explanation	Infer	Infer consequences or causes beyond the information given in the instruction	*I think there were some builder materials using asbestos on the roof so possibly this building was made in the 70s may be late 80s.* (NV1: 9-10)
Hypothesis	Generate	Make a guess at a solution or opinion, state an assumption underlying valuation analysis	*So I may suggest that value might fifty hundred and seventy five thousand pounds now* (EV1: 67)

	Evaluate	Interpret a specific cue as being consistent or inconsistent with a hypothesis	*So that kind of give us a broad view of where it might be* (EV1: 68)
Discrepancy Processing	Recognition	State a discrepancy or describe an anomalous situation existing among one or more data cues and one or more knowledge states	*But we can see an example here of a significant part of the ground floor without any first floor above it. So I can see the ground and I can see the ceiling but I can't see nothing in between EV2: 36-37)*
	Resolution	Resolving discrepancy by ignoring, explain-away or system-thinking	*So I'd question the areas for starters. Those areas don't make sense to me* (EV2: 38)
Meta-reasoning	Plan	State what is or was desired, plan a strategy, outline tasks/items to be tackled, plan for future selection of a task/item	*What we need to establish is fair comparable rent and the yield… We also obviously need to establish the cost of bringing it up to a good decorative order...*(IV1:6)
	Cue-diagnosticity	Make a general comment about a specific data cue	*Of course we have the breakdown of offices, stores etc but it is no good to us because we don't have that sort of analysis in the comparable* (IV1: 84)
	Self-evaluation	Reflect on task process, analysis or self as analyst, review progress made	*I think, probably, what it is that, I am sorry! I've probably done it wrong* (EV1: 18)
	Experiential-memory	Recall information from past experience or specific valuation encounter	*Alright I was thinking of a yield...the market at the moment is anywhere between 8 and 10* (IV2: 71)
Summarisation	Repeat-data or hypothesis	Repeat significant facts acquired from the instructional data or a hypothesis previously generated	*So we've previously decided we will use the rent of £23 per square metre to analyse the yield of comparable 4* (IV1: 78)