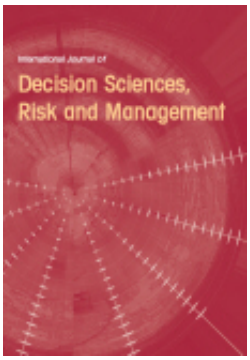

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Information and ill-structured decisions: the effects of web use and feedback

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Information and ill-structured decisions: the effects of web use and feedback

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Abstract: Most problems have information deficits, motivating decision-makers to seek additional information beyond personal experience. The World Wide Web and performance feedback are especially accessible information resources. An experiment testing the influence of web and feedback information on performance at making ill-structured decisions revealed that mere belief in the web's usefulness did not predict better decisions. Actual web use provided inconsistent benefits, but expectations-clarifying feedback consistently drove significant decision improvements. Simple knowledge-of-results feedback, however, was of no benefit. Relevant experience, the foundation on which decision information is built, also improved decisions. Scholars should consider the influence of multiple information sources on decisions, specifically ill-structured decisions. Practitioners should encourage more feedback-seeking and experience expansion while understanding the limitations of the web.

Keywords: decision-making; web; internet; feedback; performance; internet attitude; information resources; ecological validity; experiment; ambiguity; uncertainty.

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1 Introduction

We swim in a sea of information; however, searching, interpreting, and integrating information into our decisions can be a complex task made more challenging by the shear complexity of managerial decisions. Despite this, our understanding of the influences of multiple information resources on decision quality is limited. Much decision research has been conducted on decisions involving highly constrained processes, structured problems, limited information, clear alternatives, and unambiguous goals. There is little evidence of ecological validity toward the ill-structured decisions, multiple information resources, and open decision contexts common in organisations (Goldberg and Podell, 2000; Mintzberg et al., 1976; Quinan et al., 2015; Simon, 1955).

Research and practice generally assume a non-negative influence of information on decision quality [see research based on Analytic Decision Theory (Howard, 2007; Lam et al., 2011)]. This assumption persists despite extensive research that suggests the benefits of information are limited by cognitive capacity and that too much information can exceed the decision maker's ability to evaluate, process, and integrate information, and overcome biases in information processing; lowering decision quality (Edwards, 1954; Hattie and Timperley, 2007; Kahneman and Tversky, 1982; Kanfer and Ackerman, 1989; Kluger and DeNisi, 1996; Lam et al., 2011; Simon, 1955; Sweller, 1988).

Research specific to feedback often point to its performance benefits. However, reviews of this research point to the essentiality of task relevance if this information resource is to benefit performance (Hattie, 2013; Hattie and Timperley, 2007; Kluger and DeNisi, 1996). The web is widely accepted as a beneficial resource and research suggests its ease of use and supply of rich, relevant information makes benefits from this resource likely for many complex decisions (Anandarajan et al., 2006; Davis, 1989; Wallace, 2004). Cautionary evidence from Lam et al. (2011) suggests supplemental resources may add process complexity, taxing cognitive capacity and hindering performance at cognitively-intensive tasks such as complex decision making.

We propose that the performance benefits of supplemental information depend on characteristics of the information resources. To do this, we categorise information resources into self, intra-organisational, and extra-organisational resources and identify the influential characteristics of each. We then conduct an experiment to measure the influences of two common, widely accessible information resources, and the web and performance feedback, on performance at making ill-structured decisions. This work

contributes to theory and research by describing information resources in theoretical terms and examining the separate and combined effects of specific information resources on performance at making ill-structured decisions.

1.1 Definitions: ill-structured decisions and decision performance

One aspect of understanding organisational decisions is the incomplete and poor information state of most decisions—so poor in fact that those decisions are known as 'ill-structured', where the linkages between process and outcomes are ambiguous (Jonassen, 2000; Mintzberg et al., 1976; Simon, 1973; Voss, 1988). It is easy to see why a decision maker would value additional information when solving ill-structured problems but judging the usefulness of new information and integrating it effectively is difficult when the decision's structure and goals are characterised by incomplete or unclear information about the problem or how to create a solution that meets organisational expectations (e.g., Simon, 1955).

The term used here for decision quality or outcomes is decision performance. This is an expansive, empirically derived use of the term based on Aldag and Power's (1986) unique investigation into ill-structured, technology-assisted, managerial decision making. As used here, decision performance includes not only the quality of the problem solution, but also how well the problem was understood, how systematically the situation was analysed, and others' general satisfaction with the decision. This definition represents how others independently view and judge the decision.

1.2 Theory and research: information resources and decision making

Different information resources affect decision-making in different ways. Personal experience or knowledge is the first resource applied to any decision but is associated with overconfidence (Croskerry and Norman, 2008; Harvey, 1997). The web extends experience, being a vast repository of information about similar decisions and facts or details relevant to decisions outside the organisation. This type of information can fill holes in factual knowledge when making a relatively well-structured decision and may help link the decision to a class of related decisions, but it provides little information about organisation-specific expectations.

In contrast, intra-organisational feedback can reduce ambiguity about others' interpretations of decisions and the criteria they use to evaluate those decisions. Because ill-structured decisions lack clear goals, these 'acceptance criteria' become decision goals (Weick, 1995). Although valuable in concept, feedback does raise a few concerns. Others often know less about the decision or solutions than the decision-maker. The most accurate feedback appears *after* the decision.

Another concern is the contingent influence of feedback on performance. Non-specific cheerleading may not lead to increased performance. A large volume of feedback research suggests feedback must be task-relevant (Kluger and DeNisi, 1996). Merely general, conclusive evaluation, much like an unadorned score, approval, or rejection without explanation, which is common, is interpreted as a criticism of personal ability (Hattie and Timperley, 2007). More helpful feedback would be process structuring or goal clarifying. Goal clarifying feedback may also promote better information search, making feedback and web use complementary.

1.3 Hypotheses

1.3.1 Decision experience

The first information resource is personal experience. The expectation is that relevant experience improves decisions.

H1 Experience making ill-structured decisions will increase decision performance.

Experience has its limits. Characteristic of ambiguous problems, complexity and unfamiliarity motivate the pursuit of additional information (Daft and Lengel, 1983; Hoffman et al., 2004; McCune, 1999; Polanyi, 1958; Zammuto et al., 2007).

1.3.2 Web use

Prominent among information resources is the web. For this study, the *web* is narrowly defined as the technology-accessed, distributed, and searchable repository composed of thematic information pages located using search tools (Dalkir, 2013; Wang et al., 2000). To eliminate confusion with other web resources – messaging and other tools are excluded from this definition. The web is the most common and widely accessible source of extra-organisational information. Relevant to ill-structured decision making, the web describes similar decision contexts and identifies information about parameters and solution elements (Broder, 2002; Dalkir, 2013; Head and Eisenberg, 2011; Fox and Rainie, 2014; Lewin, 2013; Rose and Levinson, 2004; Shih, 2004). Despite providing access to a vast quantity of information, however, the web can be overwhelming in scope and the information is of uncertain validity and generalisability. Also, although the web is suited to many different purposes and decision types, it lacks structuring specific to ill-structured decision making (Huberman and Adamic, 1999; Khabsa and Giles, 2014; Wallace, 2004). In summary, it seems a technological information repository like the web is a better fit to well- than ill-structured tasks. The web emphasises quick decisions rather than gaining a better understanding of the problem (Gray and Durcikova, 2006), but can improve decisions if the decision-maker puts forth the effort to find relevant information.

H2 Web use will contribute to greater performance when making ill-structured decisions.

1.3.3 Feedback

Another information resource of increasing importance, where information-sharing opportunities like teamwork exist, is performance feedback. The information in feedback is not readily available from other resources. It tends to be specific to local problems and can reduce ambiguity about the expectations of those most interested in the decision (Daft and Lengel, 1986; Keith et al., 2016; Sawyer, 1992; Shapira, 2002). Gathered from coworkers and influential others, feedback contributes to shared understandings of problems and solutions (March, 1978; Weick, 1995; Weick et al., 2005).

Several studies indicate that inadequate problem information and insufficient personal knowledge motivate a search for feedback (Ashford and Cummings, 1985; Bennett et al., 1990). Those studies span several fields of inquiry, and varied tasks, and provide substantial evidence of the potential benefits of feedback (Hattie, 2013; Hattie and

Timperley, 2007; Locke and Latham, 1990; Kark and Van Dijk, 2007; Shea and Howell, 1999).

Despite feedback's potential benefits, in practice feedback often exhibits limitations such as informality and a lack of detail (Tubre and Collins, 2000; Jordan and Audia, 2012; Wood and Bandura, 1989). Feedback often consists of a mere evaluation, that is, the degree to which the decision was acceptable or liked by others but is devoid of information about the criteria others applied to reach that evaluation. This kind of knowledge-of-results or, as referred to here, 'level-only' feedback, describing the degree of performance achieved but not why it was achieved, encourages self-criticism of ability and is less effective than feedback that reduces ambiguity about others' expectations (Kluger and DeNisi, 1996). Feedback must be very decision-relevant to direct the decision maker's interpretation away from him or herself and toward the decision.

It is also observed that past studies typically assumed goal clarity, making the effects of feedback less predictable when goals are unclear. This raises the issue of feedback timing. Before the decision's formulation, both the decision-maker and other organisation members have an incomplete and imprecise vision of what comprises a good decision so, in practice, the most specific feedback comes after a decision, channelling its usefulness toward future decisions. In total, feedback is hypothesised to be most beneficial when it clarifies not just decision content, as the web potentially does, but when it clarifies decision goals.

H3 Feedback that reduces ambiguity about performance expectations will contribute to increased performance at making ill-structured decisions.

1.3.4 The joint effect of web use and feedback

Adding both web and feedback information to the decision process enables the decision-maker to adjust web use to meet others' expectations and increase decision quality more than possible if only one or neither resource is integrated into the decision process.

H4 Performance feedback and web use will contribute to greater decision performance than either resource alone when making ill-structured decisions.

The web's influence on decisions is viewed here from two perspectives – actual web use and belief in the web's usefulness as a decision resource. Belief in a technology's usefulness is a widely studied predictor of the intention to use and sustain the use of a task-relevant technology (Kim, 2009; Davis, 1989). To the extent that the decision-maker correctly and variably understands the value of web information in his or her decision making, belief in the usefulness of the web as a decision aid should predict decision performance.

H5 Belief in the usefulness of the web as a decision resource will predict greater decision performance.

2 Method

2.1 Participants and study design

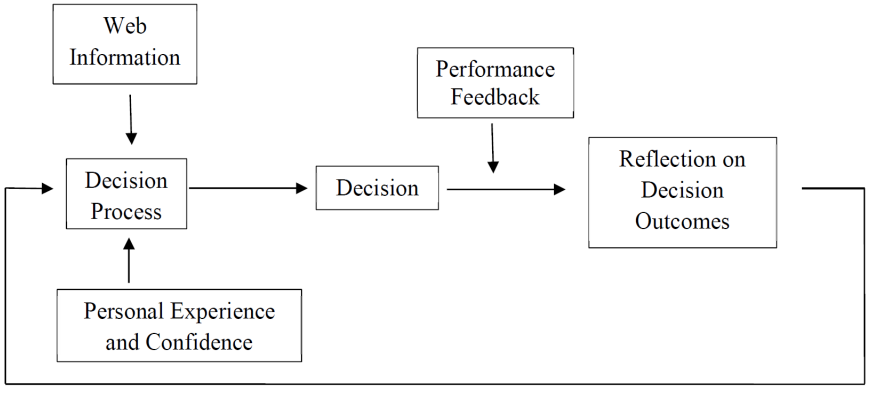
Participants in this study were 209 employees of public and private-sector organisations enrolled in a management course at a non-residential, university in the Western US. serving the region's working population. Each participant had completed studies of business decision-making. Participants reported an average of 3.5 years (*SD* = 3.3) and 5.9 years (*SD* = 4.8) of managerial and non-managerial experience. A categorical distribution of the areas of study reported by the participants was business/information systems 85.6%, engineering/computer science 4.3%, science 1.9%, medicine/healthcare 1.9%, and other/blank 6.3%.

2.2 Method of data collection

2.2.1 Design

An experimental design was used to increase control over the many influences on decisions. The 2X3 design included two web information conditions, web and no web, and three feedback information conditions; no feedback, knowledge-of-results performance score only ('level-only') in which participants received only a quantitative indication of overall performance, or 'level-and-criteria', that is, an overall performance score plus scores and descriptions for each of the 14 evaluation items, clarifying others' expectations. The intra-organisational, social information is distinguished into feedback that provides a mere evaluative reaction and feedback that adds criteria information (Weick et al., 2005).

Figure 1 Flow diagram of the experimental procedure



Notes: This is the sequence of events for a single decision during the experiment. The information inputs vary by experimental condition; approximately one-third of decision makers received no feedback and one-half did not use the web.

2.2.2 Procedure

A depiction of the experimental procedure appears in Figure 1. At the start of the experimental session, each subject received a booklet of experiment materials and was randomly assigned to a computer loaded with Microsoft word processor and browser software. Each subject was given condition-appropriate instructions. All subjects were told not to converse or interact with other subjects during the experiment. Web condition subjects were encouraged to seek web information and to use the web to assist with decision making but to exclude any mention of web use in their solutions. The browser was available on each web subject's computer for this purpose, but non-web subjects were told not to use the browser during the experiment. Staff monitored the experiment to ensure this and other rules, such as not conversing with other subjects, were enforced. A few web subjects wrote they did not use the web, and those subject's data were excluded. After verbal instructions, subjects were told to complete the pre-experiment survey items including measures of web attitude and familiarity, managerial and decision experience, and demographics.

After completing the pre-decision items, each subject turned to the first decision vignette and composed his or her solution. No time limit was placed on decision making, helping reduce any effect from differences in typing ability, accommodating the longer time that was used by web subjects, and reducing the effect of time pressure on cognitive load. After typing a solution, each subject printed a paper copy of his or her solution and delivered it to staff for feedback (feedback conditions) or collection (non-feedback conditions). Web condition subjects were required to provide the list of visited websites with their decisions. Feedback was provided by a trained staff member in writing without interpretation. Depending on whether the subject was in the level-only or criteria-and-level condition, feedback consisted of either a total performance score (range, 1 to 70) or a total score plus the list of 14 performance criteria accompanied by a score for each item (range, 1 to 5). This procedure was repeated for all four decisions.

2.2.3 Decisions

Three vignettes were developed for this study and are described in Appendix A. A fourth vignette, titled 'World Electronics', has been used by others in ill-structured decision research (Aldag and Power, 1986; Gatza et al., 1979), and was adopted to ensure that not all decisions were endogenous to the study. Each decision takes the responsible manager's perspective and provides great latitude in crafting a solution as there is no 'correct' answer. There is no suggested decision process. A test was performed to examine the degree that each decision exhibited the characteristics of ill-structured decisions. Ninety-six university business students, not participants in the experiment, answered 27 questions about decision structure. Items included "There isn't enough information in this case to make a decision", "Defining the problem in this case is not easy", "The problem is obvious", and "This case doesn't provide enough information to create a high-quality solution". Responses ranged from 1) strongly disagree to 7) strongly agree and the sum score was the metric of comparison. Possible scale values ranged from 27 and 189 with higher scores indicating less structure. Coefficient alpha in this sample ranged from .84 to .95 across the four vignettes. Means and standard deviations: *World Electronics* (M = 103.6, SD = 27.4), *C-Brew* (M = 88.8, SD = 29.4), *St. Agnes Hospital* (M = 108.1, SD = 20.4), and *The Benefits Package* (M = 89.9, SD = 27.6). Estimates for

all four vignettes are above the score range midpoint (81), providing some evidence that each decision is perceived as being ill-structured.

2.2.4 Measures of individual difference independent variables

Experience and familiarity with organisational decision making was measured with 13 items (alpha .84) each beginning with the stem "I am familiar with solving (or analysing)" and ending with the naming of problems in each of 13 business domains including marketing, management, personnel, benefits, and others. Confirmatory factor analysis was applied to this pilot-tested measure, producing acceptable goodness-of-fit statistics according to Hu and Bentler (1999) ($X^2 = 2.08$, $p = .36$; *NFI* = .99, *TLI* = .99; *RMSEA* = .02). The individual's subjective belief in the usefulness of the web as a decision aid was measured with 6 items (alpha .89; details of properties and development are described in Appendix B).

2.2.5 Measures of dependent variables

The 14-item (Aldag and Power, 1986) decision report characteristics scale was used to measure performance at making ill-structured decisions. This instrument consists of four subscales:

1 *solution quality* (4 items; alpha .89; example item "The solution was a good one")

2 *systematic analysis* (3 items; alpha .88; example item "There was systematic evaluation of alternatives")

3 *problem understanding* (2 items; alpha .92; example item "The problem statement was clear")

4 *solution acceptability and the rater's overall affect toward the solution* (5 items; alpha .84; "The solution probably would not be acceptable to all parties involved").

As measured with this instrument, performance is the degree a decision is of high quality, systematically analysed, identifies a clear problem specification, and is acceptable to others. Together, subscales 1 and 4 address quality, first from the rater's perspective and second from the rater's perception of how others would judge the decision. Subscales 2 and 3 address structure. Response options for all measures except demographic items were Likert-type with responses ranging from 1, 'strongly disagree', to 5, 'strongly agree'. The Aldag and Power instrument was also used by the experimental staff to provide level and level-and-criteria feedback during the experiment. After the experiment, five trained graduate students ('raters'), not experimental staff and blind to subjects' conditions, used this instrument to score every decision report and create performance scores. Their scores were averaged for this study's analyses and exhibited an intra-class correlation of .78. The use of this measure for both feedback and performance evaluation simulates practice where colleagues are both a source of feedback and the judges of decision outcomes.

2.2.6 Measures of covariates

Age and gender, frequently identified as influences on information technology use, were also measured and entered as covariates to improve the accuracy of parameter estimates.

3 Results

3.1 General results

Table 1 provides means, standard deviations, correlations, and alpha reliabilities for the study variables, with quality measures averaged across conditions and decisions. A total of 209 subjects completed the experiment successfully: no web/no feedback (30); no web/level feedback (31); no web/level-and-criteria feedback (30); web/no feedback (38); web/level feedback (32); web/level-and-criteria feedback (48). Web conditions were oversampled by design because it could not be predicted in advance whether subjects would actually use the web. These are final numbers as fewer than 10% of records exhibited unusable or missing data. To challenge the assumption of random assignment, tests of individual differences across the six conditions were performed. No significant differences were found for age, gender, decision experience, or pre-decision belief in the web's usefulness. Neither was there a significant trend in decision performance across the four decisions. This suggests there was no practice effect and that the decision makers had a stable decision process at the first decision. Correlations between performance scores are in part inflated because the tabled data are constructed from mean scores across the four decisions and because the first decision scores precede feedback effects.

Figure 2 Performance and web use by decision with linear trend lines, (a) solution quality by web condition (b) systematic analysis by web condition (c) problem specification by web condition (d) rater's general affect toward the problem solver's solution

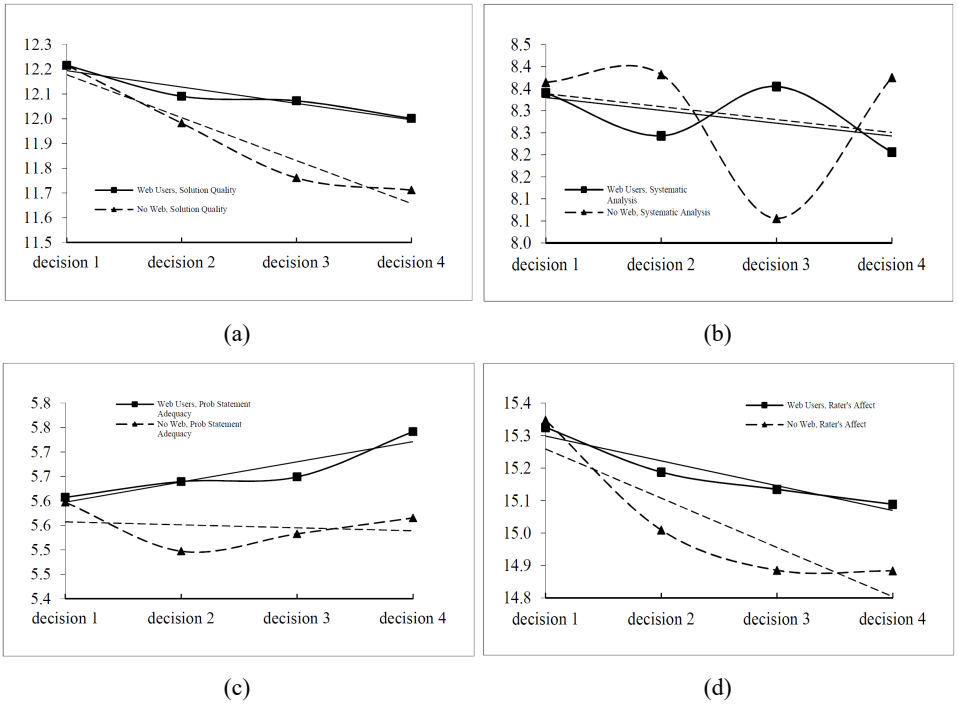


Table 1 Means, standard deviations, correlations, and reliabilities[a]

Variable	*Mean*	*S.D.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Covariates										
1 Age	25.17	(6.99)	(na)							
2 Gender	0.47	(0.50)	–08	(na)						
3 Decision experience	36.29	(8.25)	04	23**	(84)					
4 Belief in web usefulness	23.38	(4.53)	16*	–10	07	(89)				
Performance measures[b]										
5 Solution quality	12.06	(3.32)	–15*	–04	12+	06	(89)			
6 Systematic analysis	8.30	(2.62)	–12	–06	10	–06	96***	(88)		
7 Problem specification	5.65	(1.90)	–10	–08	–02	–11	79***	81***	(92)	
8 Rater's general affect	15.16	(3.95)	–14+	–07	12+	–08	98***	97***	82***	(84)

Notes: N = 209;
[a]For multi-item measures, the internal consistency reliabilities (coefficient alpha) appear in parentheses along the diagonal.
[b]Performance measures are averages for the four decisions.
+p < .10; *p < .05; **p < .01; ***p < .001, two-tailed.

Table 2 Information influences on performance

Independent variable	*Solution quality*					*Systematic analysis*				
	Est.	*SE*	*t*	*p*	*95% CI*	*Est.*	*SE*	*t*	*p*	*95% CI*
Gender[1]	–.50	.24	–2.076	.038	–.96, .03	–.35	.26	–1.376	.170	–.86, .15
Age (ln)[1]	–2.18	.49	–4.434	<.001	–3.15, –1.22	–2.38	.49	–4.868	<.001	–3.34, –1.42
Decision experience[1]	.05	.01	3.804	<.001	.03, .08	.04	.02	2.727	.007	.01, .07
Belief in web usefulness[5]	–.02	.03	–.495	.621	–.08, .05	.02	.03	–.714	.476	–.07, .03
Feedback score[1,4]	.15	.01	19.185	<.001	.13, .16	.12	.01	20.633	<.001	.11, .14
Factor	*Mean diff. SE Incr/Decr*	*SE*	*t*	*p*	*95% CI of diff.*	*Mean diff. SE Incr/Decr*	*SE*	*t*	*p*	*95% CI of diff.*
Web use[2,3]	.52	.21	2.344	.019	–.10, .94	.22	.17	1.476	.140	.10, .54
Level feedback[2,3,4]	.34	.27	1.277	.202	–.18, .86	.28	.20	1.371	.171	–.12, .68
Level-and-criteria feedback[2,3,4]	1.98	.26	5.986	<.001	1.56, 2.59	1.65	.20	6.226	<.001	1.26, 2.05
Web use X feedback[2,4]	F = .607			p = .545		F = 1.252			p = .287	

Notes: 4 decisions, 6 conditions; 1. Covariate fixed effects; 2. Mean difference statistics, SPSS 'Mixed' procedure; 3. F-value for factors; applies to both feedback influences; 4. For tests of feedback effects, the statistics reflect only post-feedback decisions 2–4 so that feedback's influence is incorporated; 5. Web users only.

Table 2 Information influences on performance (continued)

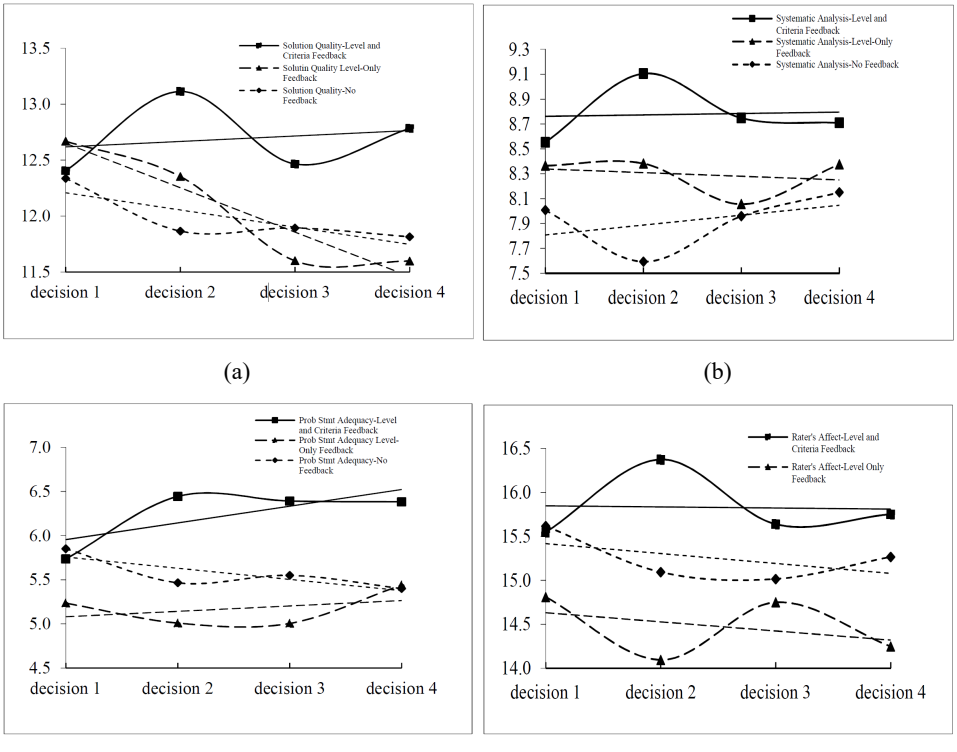
Independent variable	*Solution quality*					*Systematic analysis*				
	Est.	*SE*	*t*	*p*	*95% CI*	*Est.*	*SE*	*t*	*p*	*95% CI*
Gender[1]	–.03	.20	–.166	.868	–.42, .35	–.64	.40	–1.618	.106	–1.42, .14
Age (ln)[1]	–1.84	.37	–4.942	<.001	–2.57, –1.11	–3.69	.75	–4.907	<.002	–5.17, –2.21
Decision experience[1]	.00	.01	.372	.710	–.02, .02	.07	.02	3.358	.001	.03, .11
Belief in web usefulness[5]	–.04	.02	–1.899	.058	–.08, .00	–.04	.04	–.925	.356	–.12, .04
Feedback score[1,4]	.08	.00	17.297	<.001	.07, .09	.18	.01	20.417	<.001	.17, .20
Factor	*Mean diff. SE Incr/Decr*	*SE*	*t*	*p*	*95% CI of diff.*	*Mean diff. SE Incr/Decr*	*SE*	*t*	*p*	*95% CI of diff.*
Web use[2,3]	.30	.13	2.394	.017	.05, .55	.52	.25	1.950	.052	.03, 1.00
Level feedback[2,3,4]	–.01	.16	–.036	.971	–.32, .30	.32	.31	1.059	.290	–.28, .92
Level-and-criteria feedback[2,3,4]	1.48	.16	7.244	<.001	1.17, 1.79	2.29	.30	5.529	<.001	1.70, 2.89
Web use X feedback[2,4]	F = .361			p = .697		F = 2.241			p = .107	

Notes: 4 decisions, 6 conditions; 1. Covariate fixed effects; 2. Mean difference statistics, SPSS 'Mixed' procedure; 3. F-value for factors; applies to both feedback influences; 4. For tests of feedback effects, the statistics reflect only post-feedback decisions 2–4 so that feedback's influence is incorporated; 5. Web users only.

Most variables were roughly normally distributed but age was right-skewed so a lognormal transformation was applied. Tests of feedback and web influence were performed using a linear, repeated measures analysis on decisions 2–4 so that feedback's influence appears in the performance variables.

Data were analysed in SPSS (version 27) by applying a repeated-measures, linear model (procedure MIXED) with time-varying covariates (feedback scores) on a diagonal covariance matrix. All independent variables and factors were entered as fixed factors as determined by the study design in which each variable was comprehensive of domain. If a web subject reported not using the web, his or her data were omitted from the corresponding analysis. Web conditions were intentionally over-sampled in anticipation that some decision-makers might skip web use because it takes extra time. Examination of search histories indicated all visited websites were decision-relevant.

Figure 3 Performance and feedback by decision with linear trend lines, (a) solution quality by feedback level (b) systematic analysis by feedback level (c) problem specification by feedback level (d) rater's affect toward the solution by feedback level



3.2 Experience

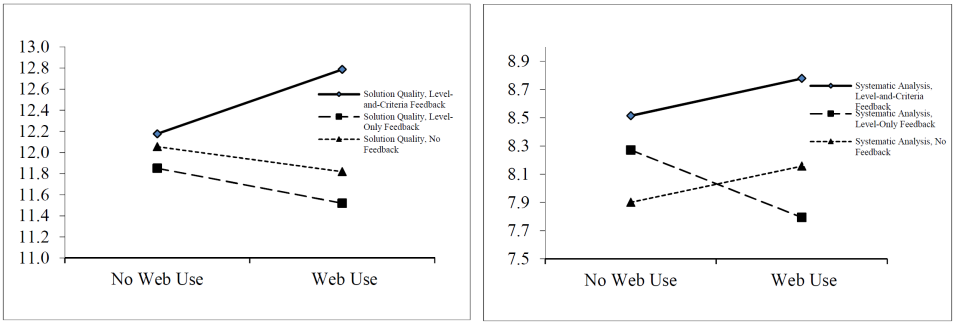
Looking at all conditions and decisions, decision experience significantly increased all measures of decision performance except problem specification (see Table 2), generally supporting Hypothesis 1. Despite its importance to effective decision making, problem

specification is often overlooked as a deliberate element of the process for many decision makers. Overall, greater experience translated into better decisions.

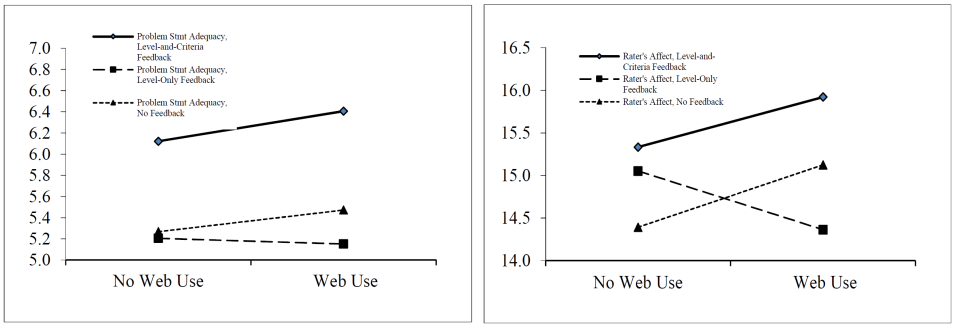
3.3 Web information

Web use had a mixed effect on performance (Hypothesis 2; see Table 2 and Figure 2), improving solution quality and problem specification. To give an alternate sense of magnitude to the web's effect, solution quality, systematic analysis, problem specification, and rater's affect were on average 2.8%, 1.1%, 4.3%, and 6.9% better. Web use adds time to the decision process, suggesting increased effort. The difference in time required to complete a decision task by web and no-web subjects was 5.04, 3.87, 3.56, and 4.44 minutes for each of the four decisions, respectively, and averaged 4.23 minutes. Decision time generally trended lower from decision 1 to 4, suggesting subjects sought either to reduce effort or became more efficient.

Figure 4 Web use and feedback, (a) web use and feedback: solution quality (b) web use and feedback: systematic analysis (c) web use and feedback: problem specification (d) web use and feedback: rater's affect toward the solution



(a) (b)



(c) (d)

3.4 Feedback information

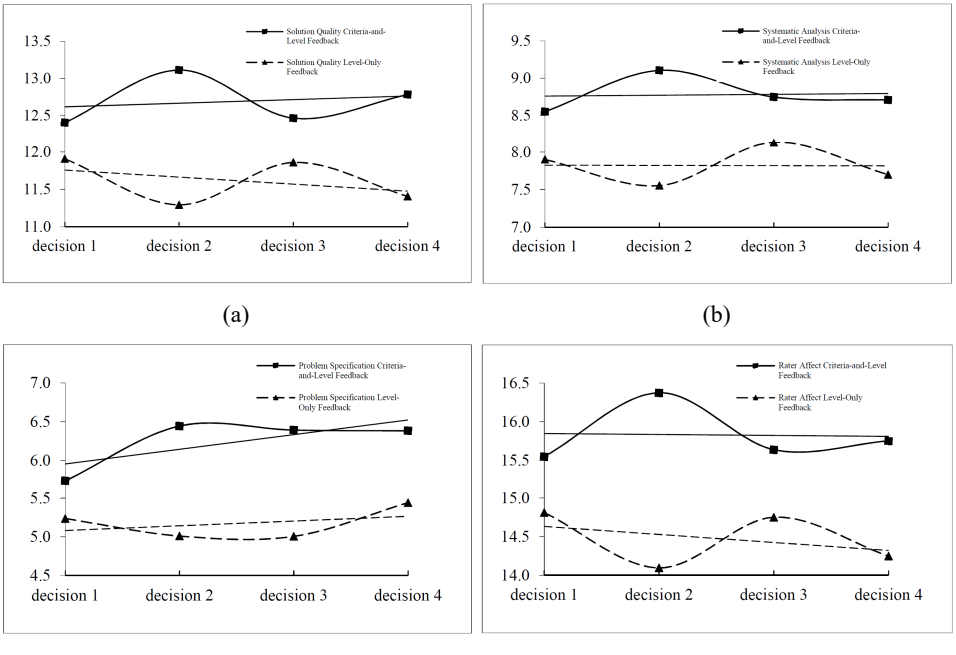
Feedback improved decisions, supporting Hypothesis 3 (decisions 2–4; see Figure 3 and Figure 4). The main effect for feedback was significant for all four performance measures. Performance improvement was greatest for level-and-criteria subjects with

level-only subjects receiving little benefit. Information about performance criteria led to 9.2%, 13.6%, 21.8%, and 7.2% improvements in solution quality, systematic analysis, problem specification, and rater's affect, respectively. Overall, criteria feedback improved decisions more, and more consistently, than did web use.

3.5 Complementary effect: feedback and web information

Figure 5 depicts how feedback and web use interact to influence decisions (Hypothesis 4). There was no significant interaction effect for web use and feedback receipt (see Table 2) providing insufficient statistical support for the idea that feedback focuses or enhances the use of the web when making these types of decisions. However, a look at the graphical evidence (Figure 5) adds more to the story. A closer look at this interaction indicates consistently improved decisions, albeit at small quantitative levels, for web users who received detailed feedback. The benefits of feedback were not consistent for decision-makers who received mere quantitative feedback or no feedback. These results suggest further investigation, perhaps with larger samples.

Figure 5 Feedback effects among web users with linear trend lines, (a) solution quality (b) systematic analysis (c) problem specification (d) rater's affect toward the solution



Looking only at web subjects, belief in the web's usefulness for decision making did not significantly influence any performance measure, countering a theoretical argument that merely perceived usefulness translates into effective web use (Hypothesis 5).

4 Discussion

This study examined the influence of information resources on performance at making ill-structured decisions. Multiple information resources were characterised then studied in a controlled context as influences on performance at making the kinds of decisions typical in organisations. The findings refine the non-negativity assumption. Information generally improves decisions, but the magnitude of influence varies with the resource and mere attitudes about a resource (the web) do not predict better decisions. As expected, experience, the first resource for making decisions, consistently leads to better decisions. There were other interesting findings. When providing information, through feedback, about others' decision criteria, decisions consistently and strongly improved. There is some indication that such feedback can improve web use when making decisions, but more evidence is needed to confirm this effect. The findings suggest, regarding ill-structured decisions that decision experience, reducing goal ambiguity, and web use lead to better decisions; however, an information-rich external resource like the web, despite its popularity and seeming value when making decisions, may not be as helpful as simply clarifying expectations.

The decision tasks and the integration of complex information did not exceed cognitive resources as some research suggests happens for very complex tasks (e.g., Lam et al., 2011; Kanfer and Ackerman, 1989); however, web use did increase the time required to complete decisions. That is one price for the benefits of using this resource.

4.1 Implications for theory and research

This study provides evidence that the assumption of non-negative information benefits generally extends to multiple information resources and helps identify conditions when those resources can combine to benefit performance. The findings also indicate that, when performance feedback clarifies decision expectations, decision quality improves; however, when a resource fails to do that, the benefits are vanishingly small (Beach and Lipshitz, 1993). It is unfortunate that performance feedback routinely arrives only after a decision is made. At that point, performance expectations may be developed post hoc by others as decision outcomes become clear. Add to this a concern that mere knowledge of results is often the only performance information readily available and information that might better guide decision making, but which would require greater analysis and forethought, is hard to find. Despite this, feedback information focused on a few decision criteria improved decisions more than drawing on the vast information resources available on the web. In the context of information-limited decisions, normative theory should recognise that information resources can contribute value to each aspect of the process that is information deficient, but that mere knowledge of results may not help.

This study also presented some research tools to assist future studies of organisational decision-making. The use of ill-structured vignettes in a controlled lab setting provided a data collection method incorporating elements relevant to practice while reducing the proliferation of confounding influences characteristic of field studies. The increased use of well-controlled designs when studying decision performance is encouraged. Also, the decision maker's belief in the web's usefulness for decision making was operationalised. Despite that instrument not producing significant evidence in this study, the instrument's properties and widespread interest in the web and decision making suggest this measure

could be helpful in the future. The decision experience instrument might also find use in both information resource and decision studies.

The findings augment those drawn from studies that assume unambiguous tasks when explaining performance. Ambiguity changes the value of information resources and limits the ability of the decision-maker to make a decision that meets expectations without seeking and making sense of information about expected and acceptable decision parameters (Schmidt and DeShon, 2010; Weick, 1995).

The findings also question whether belief in a technological resource's usefulness alone leads to higher performance when using that resource. The failure of the perceived value of web use to positively influence performance was interesting, even concerning, considering the extent that perceived usefulness is influential of intentions to use and sustains the use of technology-based resources (e.g., Davis, 1989; Kim, 2009). This is a spur to research regarding mediating mechanisms that clarify the path from the use of an information resource to performance at making ill-structured decisions. This includes research regarding factors that enhance the effectiveness of resource use or reduce unproductive effort.

It is not surprising that personal experience was a beneficial resource. This finding reminds us that the individual is central to decision making and is the one source of information that can, if sufficiently knowledgeable, address all aspects of the decision process.

4.2 Implications for the practice of assisted decision making

Exclusive reliance on a single resource, like the web, falls short of what can be achieved when drawing on other resources. This study's findings encourage organisations to examine and disseminate organisational expectations so that such expectations are widely understood. A cautionary observation is that unquestioned or excessive belief in the web's usefulness may be poorly predictive of decision performance when using the web. In organisations with adequate means, tailor-made knowledge management systems can, over time, develop into valuable sources of information specifically crafted to the organisation's decision needs; however, this complex challenge includes keeping up with ever-changing intra-organisational expectations and extra-organisational developments (Alavi and Leidner, 1999; Deparis et al., 2014; Intezari et al., 2017).

4.3 Limitations and additional needs for research

Several limitations of this study deserve mention. The specific information subjects retrieved from the web is only indirectly known through the list of visited websites. The relevance and value of retrieved web information were not measured. The number of unique websites visited did not correlate with performance measures although a superficial, qualitative inspection of the visited sites indicated the sites had face relevance. Future work should examine more closely the content of sites used and the process of locating and integrating web information into decisions. Also, each week sees incremental changes to the information available on the web and the speed with which information can be located. Every effort was made to focus this study on relatively durable factors but technological changes, like those associated with artificial intelligence and machine learning, may someday alter the nature of the studied relationships.

The study was designed to recreate many aspects of organisational decision situations but was still characterised by some artificial constraints. For example, the feedback provided expectations information but did not provide specific, decision-relevant information. Also, the lack of time pressure in the study design was intended to eliminate time pressure's influence on decision making; however, in actual decisions, time pressure is common.

The results are based on a controlled study using four brief decision vignettes, albeit similar to a variety of consequential decisions. Actual organisational decisions are even more complex and take much more time. Different decisions might have produced different results. Characteristics of the participants also deserve scrutiny. The sample was composed of individuals who are both experienced decision-makers and business students; however, despite the participants' recent study of decision-making and their familiarity with web searching, they may not be representative of all organisational decision-makers. Future studies diversifying the sample of decision-makers are warranted. Also, the method of measuring decision performance introduced its unique characteristics into the study. Alternative measures are desirable.

Many influences on decision-making have been studied; only a few were measured in this study. Individual differences were few. This study did not directly measure each decision maker's motivation nor aspiration level for performance even though this level may influence the motivational effect of feedback; however, aspiration when performance expectations are ambiguous is difficult to establish. The design of the performance feedback, with scores ranging from 14 to 70 and without prior anchors, was selected in part to make performance aspirations independent of external criteria and dependent on experiences within the experiment.

Suggested research questions include, "How is information integrated into a decision?" and, "What influences the perceived value of an information resource?" This study did not consider perceived resource validity. Research into this issue could add to understanding relationships between information resources and decision performance and might predict the motivation to use different information resources. More broadly, studies of the content of located, viewed, and used information could add to understanding these relationships.

A final concern relates to the ongoing development of technology and the accessibility of information. The benefits of web use may continue to increase and systems that support decision making within organisations should improve; however, it is not apparent that improvements in the management of a decision process are evolving among web users. Until such improvements occur, the potential benefits of web use may be constrained.

This study set out to examine, from the perspective of information- and cognition-based decision theories, the influences on performance at making ill-structured decisions of using multiple, commonly accessible information resources. The resources were roughly classified as personal, intra-organisational (personal performance feedback), and extra-organisational (the impersonal web). The conclusions drawn from the study help describe the relative value of each resource type and encourage further practical and scholarly investigations into the use of multiple information resources when making ill-structured decisions.

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Appendix A

Case problems

Four brief cases were used. The cases were designed or selected to provide a breadth of scenarios and require solutions that could be enhanced with details found on the web but would not be familiar as a group in the experience of a single problem solver. Specific attributes of solutions were not evaluated. Three case problems were designed for this study. The fourth, 'World Electronics', has been used for this purpose in previous studies (Gatza et al., 1979). The World Electronics case challenges the problem-solver to analyse the flagging sales of a retail electronics business and make a decision regarding catalogue marketing.

Descriptions of the three new cases appear below.

The benefits package

In this case, the problem-solver must develop a multi-part plan with multiple constraints and that promotes multiple company goals. "You have been hired by the manager of a small software development firm in a metropolitan area on the west coast of the United States". In this case, the decision maker is provided with information about the company including the occupations composing the workforce and a description of the current employee benefits makeup. The decision maker is asked to compose a new benefits program for full-time employees accomplishing these goals:

- perceived as fair so as not to discourage motivation
- competitive with other small technology firms in a very tight labour market
- cost and tax effective
- attractive to potential employees for recruiting purposes.

St. Agnes Hospital

The St. Agnes case, about a church-affiliated hospital in Memphis, Tennessee, challenges the problem-solver to think creatively about fund-raising techniques suitable for a not-for-profit organisation. Each problem solver is provided descriptive information about the hospital and its patient population. Because of declining revenues, the decision maker is asked to develop an innovative program that controls costs, increases revenues, or both.

C-Brew

The C-Brew case challenges the problem-solver to think creatively about enhancing the visual marketing impression made by a simple, textual webpage for a small business. C-Brew is a small Colorado manufacturer of coffee makers facing a declining market share. To date, they have not placed much attention on their website but realise the need to improve the site if they are going to stem the loss of sales to competitors. The company's website is austere, unadorned, and provides minimal information to potential

customers. The problem solver is challenged to redesign the website to make it a more effective marketing and customer-interaction site.

Appendix B

Measure of the individual's belief in the usefulness of the web as a problem-solving information resource

1 Using resources found on the web improves my solutions to school or work problems.

2 The quality of my problem solutions is increased by the use of resources on the web.

3 Use of resources found on the web speeds my problem solving.

4 Solving problems using web information results in poor quality solutions (reverse-scored).

5 Using the web helps me make more comprehensive and complete solutions to problems.

6 Using resources found on the web would make a solution to these case problems better than a solution developed without aid of the web.

Item responses are 5-anchor, Likert-type, ranging from 1, 'strongly disagree', to 5, 'strongly agree'. This measure was created for this study and was taken both before and after completion of the four case problems. A pool of items was first tested in a small pilot study and exploratory factor analysis pared this pool to 12 items (alpha 0.89). Confirmatory factor analysis results produced weak goodness-of-fit values according to Hu and Bentler's (1999) criteria. Modification indices suggested allowing several pairs of error terms to covary and inspection of those item pairs indicated similar wording or adjacency. Anderson and Gerbing (1988) recommend removing items, rather than allowing error terms to covary, to support unidimensional measurement and avoid theoretical confusion and capitalising on chance. Therefore, using item-to-total-scale correlations and modification indices, the scale was trimmed to 6 items with coefficient alphas in this study of .86 and .81 for the pre- and post-experiment measures respectively. A confirmatory factor analysis of the 6-item scale produced acceptable goodness-of-fit statistics including $X^2 = 10.63$ ($p = 0.30$ ns), ratio of X^2 to degrees of freedom of 1.18, NFI = 0.98, TLI = 0.97, and an RMSEA = 0.03.