The Effect of Note Taking on Memory for Details in Investigative Interviews

by

© Sarah MacDonald

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Abstract

Across 3 experiments, the effect of different styles of note taking, summary and access to notes was examined for memory for the details contained in a witness interview. In Experiment 1, participants ($N = 40$) were asked to either take notes or listen as they watched a witness interview. In Experiment 2, participants ($N = 84$) were asked to either take notes in one of three ways (i.e., conventional, linear, spidergraph) or listen as they watched a witness interview. In Experiment 3, participants ($N = 112$) were asked to take notes using the conventional or spidergraph method of note taking while they watched a witness interview and were subsequently given an opportunity to review their notes or sit quietly. Participants were then either granted access to their notes during testing or were not provided with their notes. Results of the first two experiments revealed that note takers outperformed listeners. Experiment 2 showed that conventional note takers outperformed those who used organizational styles of note taking, and post-hoc analyses revealed that recall performance was associated with note quality. Experiment 3 showed that participants who had access to their notes performed the best. The implications of these findings for police training programs in investigative interviewing are discussed.

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Chapter 1: Introduction

Interviewing witnesses is arguably a demanding task that requires much attention and memory for details. Negative consequences may arise if an interviewer fails to encode the details in a witness' account into memory and later retrieve those details. For instance, the inability to remember may prevent interviewers from remembering important topics in a witness' account that requires probing, remembering the source of the key investigative information they heard when debriefing investigators, or responding inaccurately to questions about the interview whilst in court. Despite the documented bounds of memory capability (e.g., Loftus, 1979; 2005), and consequential nature of an interviewer's memory for detail, limited research effort has been spent identifying and testing techniques that can enhance memory of interviewers for large amounts of complex information. One seemingly obvious tool that has been advocated to help people remember information being delivered verbally, but not tested in the interviewing context, is note taking.

There is much evidence, primarily from educational research, that note taking is an effective memory enhancing technique (Kobayashi, 2005, 2006; Ryan, 1981). Therefore, it is expected that note taking will help memory for those involved with investigative interviewing tasks (i.e., primary and secondary interviewers, interview monitors) beyond simply listening to what the witness says during the interview. In an investigative interview, if an officer chooses to take notes, he or she has the discretion to employ any type of note taking style (e.g., personal preference, taught organizational styles); however, it is not entirely clear if one style of note taking is superior to another.

In addition, officers have the discretion to review their notes following an interview, and even have access to them during opportunities for memory recall (e.g., whilst writing up reports or being questioned in court about the content of the interview). Therefore, the discretion in practices raises questions about the extent to which reviewing and accessing notes will have any beneficial effect on memory for the details in a witness' account. As a consequence, the goal of the current research is to test the extent to which (a) taking notes is useful in the investigative interviewing context, (b) any particular style of note taking is superior, and (c) reviewing notes prior to testing and having access to notes during testing (as a function of note taking style) is of benefit.

Does Note Taking Enhance Memory?

Since note taking was first examined as a memory enhancing tool, there have been upwards of 90 published articles that have assessed its effectiveness, including one narrative review and four meta-analytic reviews. Note taking studies have been conducted all over the world, including the US (Einstein, Morris, & Smith, 1985; Kiewra, DuBois, Christian, & McShane, 1988), Canada (Eskritt & Ma, 2014), and Taiwan (Chiu, Wu, & Cheng, 2013). The vast majority of these studies have been conducted in the educational domain.

There are a variety of variables that have potential to impact how well note taking helps memory for details. For example, some of these above-mentioned studies examined different styles of taking notes, such as personal style of note taking (e.g., taking notes on a blank piece of paper in any format the participant desires) and organizational styles of note taking (e.g., asking participants to use a structured style). There are also some instances (e.g., the TON used in Hope, Eales, & Mirashi, 2014) in which studies have examined a style of note taking that provides participants with headings and sub-headings to reference while they take notes using a structured style. Studies in this area also manipulate whether participants can study their notes (e.g., Carter & Van Matre, 1975) or have access to them. Specifically, some investigators will allow participants to study their notes for a period of time prior to testing, and some might allow participants to have access to notes as a memory aid during testing. Granted the wide variation in experimental designs, the main conclusion drawn from the narrative review and four meta-analytic reviews is that taking notes is a beneficial memory enhancing technique. Those reviews also suggest that the effectiveness of note taking is moderated by many different personal and situational factors. Each is reviewed below.

The earliest meta-analysis by Ryan (1981) included only studies where the effect of taking notes was examined. Specifically, his synthesis of 19 comparisons of note takers with readers on their ability to recall text-based material revealed a small, although significant, effect size (d =.22). A couple of years later, Hartley (1983) examined 57 studies through a vote-counting review and found that the majority of experiments (34) supported the hypothesis that note taking enhanced memory. However, 19 studies yielded non-significant results and four experiments revealed the opposite effect of note taking (i.e., that it hindered memory compared to listening). Although Hartley's (1983) narrative vote-counting review has documented the benefits of note taking under certain circumstances, existing meta-analytic reviews have provided a much more comprehensive and quantitative analysis of the effect that note taking has on memory.

Henk and Stahl's (1985) synthesis of 14 studies revealed a small to medium effect size (d =.34) when examining the difference in memory performance on recall of lecture material on note takers over listeners. However, it should be noted that this meta-analysis did not assess heterogeneity across studies (i.e., potential moderators) and provided very little data in the results section. This meta-analysis was also not published in a peer-reviewed journal, only in conference proceedings. Therefore, results of Henk and Stahl's (1985) meta-analysis should be interpreted with caution.

Perhaps the most comprehensive study of the effect of note-taking on memory performance was Kobayashi's (2005) analysis of 57 experiments. He found a small significant effect for the advantage of note takers over listener's memory (d =.22). More specifically, he found that effect sizes were larger when participants received training on how to take notes compared to a lack of note taking strategy intervention (ds =.53 and .26, respectively). As an example, Spires (1993) found that college students recorded higher quality notes and had better comprehension of lecture material when they were given explicit instructions with a self-questioning strategy about how best to take notes during a lecture.

The variability in Kobayashi's (2005) overall effect size was also accounted for by the age of participants. Note taking had a much larger impact on memory performance for those of a younger age (d =.43) compared to participants who were older (d =.14). Effect sizes also varied depending on if the to be remembered (TBR) material was presented in an audio-visual or only visual format. Overall, studies that presented audio information revealed larger effect sizes (d =.43) than those that presented audio-visual (d

= -.02) or simply text material (*d* =.27). The type of memory test used in experiments also accounted for effect size variability. The largest effect sizes were reported in studies that employed either a free recall task (*d* =.55) or cued recall task (*d* =.47). These effect sizes were much larger than those documented by studies that used a recognition or higher-order performance test (i.e., inference tests or tests examining information transfer) (*d*s =.18 and.26, respectively). Lastly, Kobayashi found that effect sizes were also larger if studies were published after 1970 (*d* =.36), and if the research was written in a dissertation/ERIC report (as opposed to a published journal article, *d* =.47).

Most recently, Kobayashi's (2006) synthesis of 33 studies examined the effect of note taking (with an additional period of review prior to testing) revealed a substantial effect size (*d* =.77) for the overall difference in performance on a memory task between note takers and non-note takers. In both of Kobayashi's (2005, 2006) meta-analyses, a variety of effect sizes were documented as a result of a number of moderators. Kobayashi identified moderators that explained some of the variability among effect sizes. Similar to his previous analyses, moderator analyses indicated that effect sizes were significantly larger when participants were in lower academic levels (*d* =.53) and the TBR information was presented in audio format (*d* =.53).

Does note-taking work in the legal domain? Only a few studies have been carried out in the legal domain, namely, with respect to mock juries. Most recently, Hope, Eales, and Mirashi (2014) examined note taking effects on juror recall of trial information by assigning participants randomly to either a structured note taking or control (listening) condition during a mock trial and subsequently testing their memory for trial details by asking a series of cued-recall questions. Participants who recorded notes during the mock trial using a Trial-Ordered Notebook (TON; an organizational style of note taking) recalled significantly more details compared to those who only listened to the mock trial (see also Dann, Hans & Kaye 2007; ForsterLee & Horowitz, 1997; ForsterLee, Kent, & Horowitz, 2005; Hope, Eales & Mirashi, 2014).

Although there are studies in the legal-*experimental* domain that provide support for note-taking as a beneficial memory enhancing technique, there are some field studies in the legal domain that do not provide such positive effects. Heuer and Penrod (1994) examined 160 trials conducted throughout the U.S. in which judges either permitted jurors to take notes (*n* = 103) or simply listen (*n* = 57). Results revealed no significant differences between jurors who took notes and those who listened on how accurately they recalled evidence from the trial (see also Heuer & Penrod, 1988). However, in Sand and Reiss' (1985) field study of 32 trials, jurors who took notes reported that notes served as a useful memory aid. Similarly, Flango (1980) interviewed jurors who were permitted to take notes during trial and found that those who took notes rated the decision making process easier and the quality of their deliberations higher than those who did not take notes. Although the legal *field* studies suggest that note taking provides some positive benefits to jurors (e.g., self-reported memory enhancements and improvements in decision making processes), these studies do not provide the same quality of support for note taking compared to the above-mentioned *experimental* studies. Due to the lack of quantitative experimental design (i.e., manipulation of participant note taking) and significance testing found in these field studies, the results should be interpreted with caution.

In Theory: Why Note Taking Succeeds and Fails

As described above, the meta-analytic reviews show, in general, that taking notes is a beneficial memory enhancing technique. However, studies reveal a variety of effect sizes which are based on a number of moderating variables. These situational and personal factors may dictate when note taking works well for memory enhancement and when it fails. In the following section, the general theory pertaining to note taking as a memory enhancing technique will be explained. Theory also will be used to provide explanations for instances when note taking fails as a successful tool to improve memory.

Encoding Effects. Taking notes is beneficial because it helps people *encode* the TBR information and serves as an *external* storage system (i.e., the notes can be used for later review; Di Vesta & Gray, 1972). Encoding effects are evident from research showing that note takers outperform listeners when the opportunity to review their notes is absent (Einstein, Morris, & Smith, 1985). There are a number of theoretical explanations for the benefits that note taking has on the encoding of verbal information. Note taking may enhance memory by increasing attention to TBR material (i.e., attention theory; Frase, 1970), promoting greater organization of that material, or promoting elaborative processing of ideas (Craik & Lockhart, 1972; Einstein et al., 1985). An additional theory of information processing posits that note taking encourages the integration of new TBR information with past knowledge (i.e., meaningful learning or generative processing; Ausubel, 1968).

The theory of generative processing makes similar predictions (albeit due to a different reason) to those outlined above concerning attention and effort. That is, note takers will recall more than listeners because notes provide more cognitive anchors (i.e., past experiences) upon which the new TBR information can be attached (Wittrock, 1974; Wittrock, Marks, & Doctorow, 1975).

***External Storage Effects*.** The explanation of the effect of external storage, however, is more straightforward. Note takers can benefit because they, unlike listeners, have the opportunity to review notes and consolidate the noted information (DiVesta & Gray, 1972; Rickards & Friedman, 1978). Having the opportunity to review notes may facilitate greater memory of TBR information because the review process allows for repeated exposure of the information (Bromage & Mayer, 1986; Middendorf & Macan, 2002), and may act as an aid against the threat of memory deterioration over time and distortion due to subsequent presentation of information (interference theory; Neath & Surprenant, 2003).

Encoding Specificity and Generative Processing. The encoding specificity theory (Tulving & Thomson, 1973) provides some insight into why note taking has a larger effect on free-recall tasks than cued-recall tasks (i.e., direct questions or multiple choice; see Kobayashi, 2005). *Cued*-recall tasks provide retrieval cues at the time of testing that can help listeners; thus, lessening the difference in performance between note takers and listeners. These retrieval cues are not present in *free*-recall tasks; therefore, the effect of note taking might only be evident in tests of memory that do not provide retrieval cues.

Additionally, note takers who record high quality notes would arguably benefit the most from note taking due to enhanced generative processing. In other words, good quality notes (e.g., well structured, organized) increases the chance that the idea being recorded will be connected to many of the other ideas that comprise the TBR material (Wittrock et al., 1975). The notion that note taking increases the total number of connections among ideas may explain why effect sizes are largest when note takers receive training on how to take notes or are shown different techniques that can be used when being presented with TBR material.

Divided Attention. As mentioned, there are instances when taking notes may not work. Note taking is arguably a difficult task and requires the note taker to engage in a series of activities. Firstly, the note taker must be able to keep a certain amount of information in memory (see Baddeley, 2001), at the same time must select pieces of information perceived to be important, and then transcribe this information being stored in working memory before it is forgotten (Peverly et al., 2007). Peverly and colleagues (2007) suggested note taking may not be a beneficial activity if any of these variables (i.e., working memory, ability to select important information, and transcription fluency) are hindered in any way. Research (Kabayashi, 2005) has identified potential contextual factors that might inhibit the encoding effect of note taking by using up cognitive resources that could otherwise have been available for the note taking task.

In his meta analysis, Kobayashi (2005) identified *presentation mode* as a significant predictor of variance, whereby studies that administered audio information as the TBR material reported larger effect sizes (d = .43) compared to studies that utilized text (d = .27) or audio-visual (d = -.02) TBR material. Encoding visual material (e.g., text based or audio-visual material) might limit the amount of attention that can be devoted to one's notes (using pen and paper) because these two tasks are utilizing resources in the same modality. Material that is presented in audio format (e.g., a lecture or an account provided by a witness during an investigative interview), however, allows for full visual attention to be directed towards the note taking task, which could explain why the effect of note taking is greatest when the TBR material is presented in audio format.

In addition to presentation mode of information, other contextual variables might negatively impact the encoding effect of note taking. Cook and Mayer (1983) suggested that if TBR information presentation rates are too fast or contain information that is too complicated, then the majority of cognitive resources are likely to be utilized just to process and understand the TBR information, resulting in limited resources remaining for note taking. For example, Peters (1972) examined performance on a multiple-choice test for note takers and listeners when information was presented at either a normal or a fast rate. Results showed that, in the fast paced condition, there was no difference in performance on the multiple-choice test between note takers and listeners. This finding suggested a lack of encoding effect of note taking in this context (see also Aiken, Thomas, and Shennum, 1975).

Note Taking Styles

The degree to which note taking serves as a memory aid may be heavily dependent on the style of one's notes (Kiewra & Fletcher, 1984). Conventional notes, or notes taken in any style or without an imposed organizational structure tend to be considered ineffective because those notes often contain less than 40% of the TBR material (Bretzing & Kulhavy, 1981; Kiewra & Benton, 1988; O'Donnell & Dansereau, 1993). Kiewra and his colleagues (1991) found that when students were provided with a matrix framework to guide their note taking (i.e., a two-dimensional table containing pre-determined vertical and horizontal headings with space in each intersecting cell to record notes) when listening to TBR information, they recalled significantly more details on a subsequent memory task compared to students who took conventional notes. Kiewra and colleagues (1988) also found that students who reviewed matrix and linear style notes (i.e., notes organized in a list with different headings) performed better on a test than those who studied a complete text of the TBR material.

Two theories may explain why those who take notes utilizing an organizational method (i.e., matrix or linear framework) outperform those who take conventional notes. First, organizational systems encourage note takers to record a larger number of ideas, resulting in a more *complete* account of TBR material (Kiewra, Mayer, Christensen, Kim, & Risch, 1991). It has been suggested that the completeness that emerges from the use of pre-set headings may increase attention to important topics, and the space provided in each cell may allow for a larger written record of recalled ideas. Second, it could be that the combination of headings and sub-headings found in organizational frameworks facilitate learning through *internal connections*. Specifically, taking notes in a way that facilitates the formation of relationships among topics should allow for greater memory compared to those who take notes typically in a chronological order, without making meaningful connections between topics (Mayer, 1984).

Current Note Taking Practices in Police Interviews

The ability to comprehend and utilize information provided by witnesses during live interviews is of consequence for investigations. Although the majority of witness interviews for serious crimes are audio/video recorded in many jurisdictions (which means that they could, in theory, be watched/analyzed at a later date to refresh memories), the effect of note-taking *during the interview process* requires testing because note-taking may help officers perform effective interviews, and may subsequently improve their memory for details at a later point in time (e.g., debriefing meetings that follow interviews).

To be clear, note taking serves as more than an aid for producing a written statement (in the absence of audio/video recording). Note taking may serve as a memory-enhancing tool across a variety of investigative interviewing tasks. Importantly, police officers may take notes when the witness is providing an uninterrupted free narrative of an incident. Upon hearing the free narrative, the interviewer must identify subsequent topics (people, location, thoughts, conversations, objects, physical actions, or times) that need to be probed in much greater detail. For the remembering of important topics, it is not feasible for interviewers to stop the interview, watch the recording of what was said, and then proceed with the interview again. Taking notes during the interview can also help interviewers create structured summaries of the completed interview; note taking may aid the writing of these summaries by increasing the likelihood that a more accurate account of what the witness said during the interview is captured. Although asking officers to watch their interviews prior to creating their summaries is the ideal approach, such a practice does not always happen in reality (e.g., time constraints). In addition, note taking may help the second interviewer (who often sits passively in the interview room and takes notes) understand the witness' account so that s/he can assist the primary interviewer with various tasks during the interview, such as identifying important topics to probe. Further, interviewing teams might include a monitor who observes interviews (i.e., watching live video) from a separate room. Similar to a second interviewer, the monitor may take notes in order to provide interviewing guidance to those conducting the interview.

Although the available literature is clear that note taking serves as a useful tool in helping people remember details from information presented verbally, and therefore should help police officers remember details from a witness' account, there is limited quantitative data on its use in reality and even some controversy surrounding recommendations about whether officers should take notes during witness interviews. Informal conversations with police officers suggest that note taking practices are left to the discretion of the investigative interviewer. In North America, only a small group of officers – who have undergone intensive interview training (the PEACE model of interviewing) – are taught to follow a specific structure known as the spidergraph method of note taking (i.e., a method of note taking in which headings are recorded inside circles with accompanying details recorded surrounding those circles; see Marlow & Hilbourne, 2013; but adherence is unknown[1]). National guidelines recommend that officers in the UK should not be responsible for taking notes beyond those that might help them

[1] Anecdotally, in popular television shows such as the First 48, the viewer rarely sees the police officers taking notes.

understand the free recall provided by the interviewee (Achieving Best Evidence, 2011). In addition, The Lamer Commission of Inquiry (2006) into wrongful convictions in Newfoundland and Labrador in Canada revealed that even an experienced officer did not take notes while interviewing key witnesses and subsequently had no memory for the content of those particular witness interviews. The Lamer Inquiry highlights the consequences of common misconceptions regarding officers' confidence in memory and the belief that note taking is not a necessary activity during investigative interviews.

More recently, a document published by the RCMP discourages the note taking practice in investigative interviews, explaining that it can be very distracting for the interviewee. Not only does the RCMP state that note taking should be avoided or minimized as much as possible, they warn that taking notes could also negatively impact the interviewee's account, whereby the interviewee may censor themselves or omit information for fear of having it recorded on paper by the interviewer. These guidelines, along with the above-mentioned misconceptions regarding confidence in memory, have incredible implications for investigative interviewing practices in the field. This is worrisome due to the lack of scientific research these recommendations are based on.

Although experimental studies on the effect of note taking on memory for details of a witness' account are non-existent, there is some tangential investigative interviewing research that suggests that note taking maybe a beneficial tool for interviewers. For instance, Warren and Woodall (1999) reported that interviewers remember, on average, only 80% of the major details and only 60% of the minor details contained in a child's account. Lamb and his colleagues (2000) found that interviewers left out 25% of the substantive details (i.e., forensically relevant) when asked to write down everything that the child witness said during the interview. Cauchi and Powell (2009) examined notes associated with actual alleged child abuse cases and reported a high degree of variability in note quality, in that only some notes reflected near-verbatim accounts for parts of the interview. Cauchi, Powell, and Hughes-Scholes (2010) found that police officers only recorded 61% of all crime related details in their notes when asked to watch a mock child abuse interview. More recently, Gregory, Schreiber-Compo, Vertefeuille, and Zambruski (2011) have shown that although police officers' notes are generally accurate, these notes lacked almost 70% of the information presented during an interview. Powell, Sharman, and Cauchi (2011) found encouraging results after a brief interview training course whereby officers recorded more questions and more information in their notes while listening to a witness interview. Although there are concerns that contemporaneous notes do not fully capture interviews (i.e., interviews should be recorded), it remains unclear as to the extent to which the act of note taking improves interviewers' comprehension of witness accounts. These findings, coupled with the benefits of note taking outlined in the educational domain, provide the basis for preliminary research into the effects note taking might have in an investigative interview setting.

The Current Research

The goal of the current research is to conduct preliminary tests of the effect of note taking in an investigative interview setting. In the following three experiments, a methodology that is employed in the educational literature (i.e., listening to/watching stimuli) is used in order to investigate the effect of note taking on memory for details of witness interview. The scenarios presented to participants are akin to what would be faced by an officer who monitors an interview and a secondary interviewer. That is, as a starting point for a program of research, participants did not encounter the same cognitive demands that would likely affect a primary interviewer (e.g., thinking of follow up questions, building rapport, etc.). Across three experiments, the extent to which note taking is of benefit for memory retrieval in an investigative interviewing setting was tested.

Based on extant note taking research, it is predicted that note takers will outperform listeners on tests of memory recall. Specifically, it is predicted that note takers will provide a greater number of correct details, fewer incorrect details, and overall more accurate accounts compared to listeners. It is also predicted that, in Experiment 2, those who use an organized note taking style (i.e., linear, spider graph) will outperform those who follow a conventional note taking style on the same dependent measures.[2] Lastly, it is predicted that, in Experiment 3, those who have the opportunity to review and have access to their notes during testing will outperform those who do not get to review their notes or have access to them. In addition, the extant research also led to the prediction that performance will vary as a function of note quality – moving from low quality to high quality notes will be associated with better performance based on the abovementioned dependent variables.

[2] Due to the inability to be made aware what content will be presented during a witness interview, the matrix style of note taking would not be a feasible tool in an investigative interview setting. For the remainder of the paper, organizational note taking styles will refer to linear and spidergraph note taking methods.

Chapter 2: Experiment 1

As mentioned in Chapter 1, note taking has been shown to be an effective tool for enhancing memory. Research examining effects of note taking has focused generally on either encoding or external storage effects. At the most basic level, the act of taking notes (without ever reviewing or accessing them) will facilitate memory for information, which is explained by the encoding effect. Encoding effects of note taking were distinguished first by DiVesta and Gray (1972), and typically require a test of knowledge acquisition (following a presentation of to-be-remembered material), whereby performance is compared between listeners and a group that has been permitted to take notes. Although results have been mixed (see Hartley, 1983; Kiewra, 1985 for reviews), most findings suggest that encoding effects contribute to learning (Barnett, DiVesta, & Rogozinski, 1981; Bretzing & Kulhavy, 1981; Fisher & Harris, 1973).

The literature described in Chapter 1 is clear that note taking serves as a useful tool in helping people remember details from information presented verbally, and therefore should help police officers remember details from a witness' account. However, there is limited quantitative data on its use in reality and even some controversy surrounding recommendations about whether officers should take notes during witness interviews. The first experiment in this program of research is a basic test to examine the effect of note taking on memory for details found in a witness' account. Due to the preliminary nature of this area of research, a basic series of tests are required before the research can develop to use more ecologically valid designs (e.g., examining note taking practices with police interviewers in the field).

Method

Participants. Participants ($N = 40$) were undergraduate students from Memorial University. The sample consisted of four men ($M_{age} = 20.75$, $SD = 1.50$) and 36 women ($M_{age} = 21.36$, $SD = 2.59$). The average year of study was 3.36 ($SD = 0.83$).

Design. A single factor between subjects design was used, with note taking as the independent variable (note takers vs. listeners). Dependent variables were percent of correct and incorrect information recalled by witnesses during the free recall task, and error rate. Participants' notes were also coded for the percent of correct and incorrect information recorded on paper, and were classified as either *high* or *low* quality. See the Coding Procedure section below for operational definitions of the dependent variables.

Materials**.** An authentic interview transcript of a police witness interview formed the basis of the video re-enactment interview that was used as stimuli. The interview portrayed a police officer questioning a witness about an assault. Although two students played the roles of the police officer and witness, only the witness was visible. All identifying information in the actual interview transcript (e.g., names, addresses) was replaced with alternate information. The interview lasted for 13 minutes and 58 seconds.

An experimental program was designed using Visual Basic 5 software. Visual Basic software simply allowed participants to take part in the study and follow along with the experimental procedure on the computer, which prompted participants to follow along with the experiment. This program consisted of four different forms, each of which was displayed on a computer monitor in sequence. The first form contained demographic questions regarding the participants' age, gender, and year of study. Participants were asked to type their responses into a text box. The second form contained instructions on how to complete the experiment. For those who were assigned randomly to the note taking condition, instructions included the direction to take notes while listening to the interview. Participants were told to take notes in their preferred way. Participants in the listening condition were told to listen to the interview. In both conditions, participants were told they would be tested on the contents of the interview. The third form contained a video of the witness interview. The fourth form contained instructions asking participants to "Please recall in as much detail as possible what the witness said during the interview". Located below this instruction was a text box for participants to type their answers, all answers were saved automatically in a Microsoft Word document.

Procedure. The study was conducted in the Psychology and Law Lab at Memorial University. Each participant was greeted at the entrance to the lab and directed to one of four computer testing stations. Participants were then asked to read and sign an informed consent form. Next, the experimental instructions were outlined briefly, and it was verified that the participant understood how to complete the study. Participants were then provided with a pair of headphones to listen to the videos, assigned randomly (n = 20 per condition) to one of the two conditions (note taker or listener) and instructed to begin the experiment. Listeners were not provided paper or pens, and were not permitted to take notes. Note takers were provided with paper and a pen. Note takers were instructed to take notes about what the witness was saying during the interview in any style they felt most comfortable. The researcher was present in the room while the participant was engaged in the experiment and monitored that the note takers took notes and listeners refrained from taking any notes. The researcher monitored each participant to ensure that their notes were turned over during the questioning phase (so they no longer had access to their notes). The researcher examined notes recorded by the participants to ensure that they followed the instruction to take notes about the interview. There was no statistically significant difference in participants' age, gender, or year of study across the conditions (ps > .05). Upon completion of the experiment, each participant received a debriefing form that outlined the purpose of the study. The experiment took approximately 30 minutes to complete, and participants' names were recorded so that they would receive a bonus point in their applicable psychology course as compensation for their time.

Coding procedure. Memory for details was measured by coding participant responses for the number of correct and incorrect details reported. A coding guide was created that contained 115 individual idea units. For example, if a participant recalled a *tall man wearing a black shirt,* then they would receive credit for four idea units (i.e., tall, man, wearing a shirt, the shirt was black). If a participant recalled a *tall man wearing a yellow shirt,* then they would receive credit for three correct idea units but also one incorrect idea unit (i.e., the shirt was yellow). Each participants' response was coded by identifying how many of the 115 idea units were correct or incorrect. For ease of interpretation, the correct and incorrect details were then converted to percentages. A measure of error rate was also created by dividing the total number of incorrect details by the total number of details reported, and then multiplying that number by 100. This value is particularly important because it reflects both the amount of correct and incorrect information recalled by the participants. For example, a mere increase in errors does not render a particular style of note taking as less effective. Error rate takes into account both the correct and incorrect information to provide a measure of how reliable the response is (see Memon & Stevenage, 1996).

The notes were also coded for correct and incorrect details pertaining to the 115 idea units. Each set of notes was coded as either “high quality” (i.e., legible, organized, and contained sufficient detail about the witness’ account), or “low quality” (i.e., difficult to read, not organized, and contained very little detail).

Inter-rater reliability. Coding agreement of the variables was assessed by having an independent researcher code the entire sample. The independent coder was provided with a 1-hr training session that consisted of the structure and content of the coding guide as well as the practical aspects of coding participants’ responses. The coder also participated in a practice session that covered the coding of two interviews before beginning to code the actual interviews. Any confusions pertaining to the task were resolved before inter-rater reliability commenced. Inter-rater reliability was assessed with Kappa (κ). Kappa revealed acceptable agreement ratings of $\kappa = 0.94$, 0.76, 0.72, and 0.71 for the correct details recorded in participants’ notes, correct details found in participants’ responses, incorrect details found in participants’ responses, and the quality of participants’ notes, respectively.

Results

Inferential Statistics. Performance for note takers and listeners was assessed using independent *t*-tests. The measures of memory performance for note takers and listeners are shown in Table 1. As can be seen, note takers recalled a significantly larger percentage of correct details (M = 38.65, SD = 7.44) than listeners (M = 29.43, SD = 11.99), $t(38) = 2.92$, $p = .006$, $d = 0.92$. Note takers and listeners did not differ significantly in terms of the percentage of incorrect details reported, $t(38) = -1.68$, p = .10, but there was a medium effect, $d = 0.53$. Note takers provided accounts that had a significantly lower error rate (M = 6.21, SD = 4.73) than listeners (M = 12.49, SD = 6.09), $t(38) = 3.64$, $p = .001$, $d = 1.18$.

Analysis of Quality and Content of Written Notes. In nine cases (47%), participants' notes were coded as low quality. Note taking quality was significantly correlated with the percentage of correct details recalled, $r = 0.58$, $p < .05$, whereby high quality was related to a larger percentage of correct information recalled. Note quality was not significantly correlated with the percentage of incorrect details or error rate, ps > .05. Additionally, an analysis of participant's *written notes* did not reveal a statistically significant correlation between note quality and the percentage of correct details, $p > .05$. Inferential statistics were not carried out for comparisons between high and low quality because quality was not manipulated. However, measures of memory performance for those who took high quality and low quality notes are shown in Table 1.

Discussion

The first experiment examined the effect of taking notes on memory recall for details obtained in an account from an interview with a witness to a crime. In line with our prediction and findings from past research, note takers recalled a greater number of correct details, fewer incorrect details, and provided responses with lower error rates than those who listened. In line with our second prediction, quality was significantly associated with the percentage of correct details recalled, in that high quality was related to a greater percentage of correct details recalled. Unsurprisingly, the effect size for performance was large when high quality note takers were compared to listeners; a finding that is consistent with previous educational literature indicating that the benefit note taking has on memory is heavily dependent on the quality of one's notes (Kiewra & Fletcher, 1984).

Note takers who recorded high quality notes arguably benefitted the most from note taking, which may have been due to enhanced generative processing. In other words, note takers who wrote down details in a well structured and organized manner increased their chances that ideas being recorded would be connected to many of the other ideas that comprise the TBR material (Wittrock et al., 1975). Although note takers in the current Experiment did not receive specific training regarding the best way to take notes, those who took good quality notes naturally likely increased the total number of connections among ideas, which may explain why they performed better on the memory task compared to listeners and other note takers who did not take good quality notes.

There are a number of issues that must be discussed pertaining to limitations of the current experiment. Although the sample size is sufficient for finding a medium-sized effect, it was relatively small. The effect size for the difference in performance between note takers and listeners was small, but any improvement is of the utmost practical importance in an applied setting. For example, an investigation may benefit greatly (i.e., an increased chance of a resolution) if a police officer is able to recall an additional small number of evidential or investigative details as a result of taking notes. The artificial nature of the current study is also a limitation. The interview shown to witnesses was short in comparison to the length of a typical interview in an actual investigation. We predict that longer and more complex interviews will result in greater benefits of note taking because the cognitive load on listeners would likely be larger than that of note takers. In addition, the relative benefits of note taking are likely to be more pronounced when the interviewer has to use more cognitive resources (e.g., by formulating and asking questions, engaging in social interaction).

Given that past research has been conducted indicating note taking *style* plays a role in how much note taking can enhance memory, the effect of note taking *style* was investigated in Experiment 2. Conventional note taking will be compared to two organizational styles of note taking; one that is currently taught to police officers in North America (i.e., the spidergraph method). As mentioned, we predict that note takers who were trained in and implemented an organizational note taking system will recall more correct details from a witness' account, recall fewer incorrect details, and would exhibit a decrease in error rate in their responses. In addition, we also predict that our results from Experiment 1 will be replicated; note takers (regardless of condition) will outperform listeners.

Chapter 3: Experiment 2

As mentioned in Chapter one, one potential reason for the variability in note taking effectiveness could be the style of one's notes (Kiewra & Fletcher, 1984). Organizational systems of note taking include a variety of methods. Linear note taking involves recording information with headings so that superordinate-subordinate relations of the to-be-remembered (TBR) material are made apparent. The matrix style of note taking involves a two-dimensional table that includes headings and sub-headings as vertical and horizontal matrix headings, and the note taker must fill in the intersecting cells. The spidergraph style of note taking is a method of note taking where headings are recorded inside circles with accompanying details recorded surrounding those circles (see Marlow & Hilbourne, 2013). Another method, such as the Trial-Ordered Notebook (TON), consists of a framework to support and facilitate structured note taking for jurors during a trial (Hope et al., 2014).

Research investigating the effectiveness of organizational styles of note taking has found that, in general, organizational methods produce better performance on memory tests than those who take notes in a conventional or freestyle manner (see Kiewra et al., 2005). Indeed, Kobayashi's (2006) meta-analysis identified interventions such as providing framework notes or outline notes, led to the best performance on knowledge acquisition tasks. Kobayashi (2006) suggested this type of organizational note taking style directed the note takers attention to the most important details of the TBR material, as a result of the use of headings.

Theoretically, the cues present in an organizational style of note taking (e.g., headings) should enhance memory based on Mayer's SOI (selection, organization, and integration) model of learning (Mayer, 1996). The headings found in organizational note taking methods should help the note taker *select* important lecture material and organize the incoming information in a comprehensive manner in short term memory, leaving them to integrate the information with existing knowledge in long-term memory (Hope et al., 2014). For example, Titsworth and Kiewra (2004) compared test performance for students who either took notes or did not take notes during a lecture, and either listened to the lecture with or without spoken cues. Results indicated that each variable (note taking and cueing) increased performance on the memory test. Students who took notes recalled 13% more information than those who simply listened and students who listened to a lecture with organizational cues recalled 15% more information than those who listened to an un-cued lecture. Most interestingly, students who took notes while listening to a cued lecture recalled 25-29% more information compared to all other conditions. Cueing during the lecture not only increased the amount of information students recalled at testing, but it also prompted students to record significantly more details than those who took notes during a lecture without organizational cues. The finding that cueing leads to enhanced recall provides support for Mayer's SOI model overall, as the lecture information has arguably been transferred and integrated into long-term memory.

Although organizational styles of note taking have been shown to be promising with respect to enhancing memory for learned material, typical styles outlined in previous research are not necessarily suitable for an investigative interview. More specifically, it would be difficult for police officers to create framework (i.e., matrix) notes including important pieces of information prior to an investigative interview[3]. Notes taken from an interview with a witness, victim, or suspect must follow the narrative of the interviewee, as the police officer is unlikely to be aware of all important topics raised by the interviewee during the free recall. For this reason, linear framework and matrix note taking styles are not ideal for an investigative interview setting. However, it would still be feasible for an interviewer to take notes using a structured organizational method; the style of note taking would need to be feasible to carry out simultaneously while the interviewee is providing their recall of the event.

As mentioned in Chapter one, one organizational method of note taking that some police officers are trained in is called the spidergraph method (see Marlow & Hilbourne, 2013). The spidergraph method consists of headings that are recorded inside circles with accompanying details recorded surrounding those circles. Unlike framework linear or matrix note taking, this type of organizational method is feasible for officers to engage in simultaneously while listening to an interviewee's account (i.e., it is not necessary to have pre-determined headings going into the interview).

Although some PEACE-trained officers have been taught the spidergraph style of note taking, there is a dearth of empirical evidence to suggest it enhances the interviewer's memory for details in the interviewee's account more so than conventional styles of note taking. In addition, it is possible for interviewers to take notes in a linear

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[3] The matrix style of note taking may be suitable in cases whereby the interviewer obtains the witness' free recall in advance and would be able to identify key topics (pre-determined headings) prior to the interview.

fashion (i.e., a method that consists of major headings and jot notes of information pertaining to each heading) without pre-determined headings. Unlike conventional styles of note taking, a linear method would organize information in such a way that superordinate-subordinate relations of the TBR material are made apparent to the interviewer.

Given that the goal of the current research is to examine the bounds of note taking in an investigative interview setting, and to explore note taking practices that result in the best memory for details found in a witness' account, Experiment 2 was conducted with the goal of examining multiple styles of organizational note taking and the impact that they have on memory. The first hypothesis of Experiment 2 was that we would replicate findings from the first experiment, whereby note takers (regardless of note taking style) would outperform listeners on the memory task. Secondly, we predicted that note takers who utilize organizational styles would outperform those who took conventional notes. Finally, we also predicted that, as in Experiment 1, high quality notes would be related to recalling more correct information.

Method

Design. A single-factor between subjects design was used, with note taking as the independent variable with four levels: spidergraph; linear; conventional; and listeners. Dependent variables were percent of correct and incorrect information recalled by witnesses during the free recall task, and error rate. Participants' notes were also coded for the percent of correct and incorrect information recorded on paper, and subsequently classified as either *high* or *low* quality.

Participants. Participants ($N = 84$) were undergraduate students from Memorial University. The sample consisted of 22 men ($M_{age} = 21.50$ years, $SD = 2.45$) and 62 women ($M_{age} = 21.58$ years, $SD = 3.66$). The average year of study was 3.35 years ($SD = 1.00$).

Materials. Note taking training material was provided to participants who were randomly assigned to either the linear or spidergraph conditions. Training consisted of an instructional video that was divided into the following sections: a) a description of the note taking style, b) a demonstration of how to use the note taking style when listening to a verbal account, and c) an opportunity to practice the style (i.e., linear or spidergraph). The lengths of the training videos for the linear and spidergraph note taking styles were 5 minutes and 40 seconds and 6 minutes and 10 seconds, respectively. The linear note taking style was presented as a method that consists of major headings and jot notes of information pertaining to each heading. For example, a major heading might be the name of a person (e.g., the culprit in an armed robbery), and all information recorded in jot notes below the heading would be fine grain details (e.g., description of robber's appearance) about that person. Similarly, the spidergraph method of note taking consisted of major headings located in the middle of a circle. All details pertaining to that heading would be recorded as jot notes around the circumference of that circle.

Authentic interview transcripts of witness interviews formed the basis of two video re-enactments that were used as stimuli. Two different stimuli were used to ensure that any effects of note taking were not due to the type of stimuli used. Both interviews consisted of a police officer questioning a witness about an assault. Although two undergraduates played the roles of the police officer and witness, only the witness was visible in the video. All identifying information found in the actual interview transcripts (e.g., names, addresses) was replaced with alternate information. The first interview lasted 6 minutes and 50 seconds and the second interview lasted 6 minutes and 40 seconds.

Procedure. The study was conducted in the Psychology and Law Lab at Memorial University. Each participant was greeted at the entrance to the lab and directed to one of four computer terminals. Participants were then asked to read and sign an informed consent form. The experimental instructions were then outlined, and it was verified that the participant understood how to complete the experimental task. Participants were then provided with a pair of headphones to listen to their video, randomly assigned to one of the four conditions (i.e., listening, conventional note taking, spidergraph note taking, or linear note taking), and instructed to begin the experiment. Half of these participants were assigned randomly to Interview 1 and the other half to Interview 2. Note takers were provided with paper and a pen. Participants in the linear or spidergraph condition were instructed to watch an instructional video that provided them with training on how to take those particular styles of notes. Upon completion of the training videos, the researcher ensured that participants in the linear and spidergraph conditions completed the practice session utilizing the assigned note taking condition before moving forward with the experiment; all participants followed the directions. Conventional note takers were instructed to take notes in their preferred way.

Participants listened to one of two interview stimuli, and depending on the condition they were assigned to, they were to either take notes or to listen. Once the participants finished listening to the witness interview, they were asked to respond to a question located in a text document on the computer, which read "Please recall in as much detail as possible what the witness said during the interview". Participants were asked to type their answers into the word processing software.

Upon completion of the experiment, each participant received a debriefing form that outlined the purpose of the experiment. The experiment took approximately 40 minutes to complete, and participants' names were recorded so that they would receive a bonus point in their applicable psychology course as compensation for their time. There was no statistically significant difference in participants' age, gender, or year of study across the four conditions (ps > .05).

Coding procedure. Memory for details was measured by coding participant responses for the number of correct and incorrect details reported. A coding guide was created for each interview (Video 1 and 2) that contained 87 and 69 individual idea units, respectively. Coding units were broken down in a similar manner as discussed in Experiment 1. Each participant's response was coded by identifying how many of the idea units were correct or incorrect. For ease of interpretation, the memory measures were then converted to percentages. For example, the percentage of correct information was measured by dividing the number of correct details by the total number of possible correct details (i.e., 87 or 69) and then multiplied by 100. A measure of error rate was also created by dividing the total number of incorrect details by the total number of details reported, and then multiplying that value by 100.

The notes taken by those assigned to the note taking conditions were also coded for correct and incorrect details pertaining to idea units. In addition, each set of notes was coded as either "high quality" (i.e., legible, organized, and contained sufficient detail about the witness' account), or "low quality" (i.e., difficult to read, not organized, and contained very little detail).

Inter-rater reliability. The first author coded 100% of the sample. Coding agreement of the variables was assessed by having an independent researcher code 20% of the sample. The independent coder was afforded the same training and practice session as in Experiment 1. Inter-rater reliability was assessed with Kappa (κ). Kappa revealed acceptable agreement ratings of $\kappa = 0.94$, 0.73, 0.67, and 0.66 for the correct details recorded in participants' notes, quality of participants' notes, correct details found in participants' responses, and incorrect details found in participants' responses, respectively.

Results

Inferential Statistics. Performance for note takers (spidergraph, linear, and conventional) and listeners was first assessed using a one-way ANOVA, and subsequently followed up with independent *t*-tests. There were no significant differences on any performance measures for participants who viewed Interview 1 compared to those who viewed Interview 2 (ps > .05; therefore, all results presented are collapsed across

Interviews). The measures of memory performance for listeners and note takers who took conventional, spidergraph, and linear notes are shown in Table 2.

A main effect of note taking was found for the percentage of *correct* details recalled, $F(3, 80) = 4.03$, $p < .01$, $\eta_p^2 = 0.13$. Conventional note takers recalled a higher percentage of correct information ($M = 37.88$, $SD = 8.81$) than listeners ($M = 28.11$, $SD = 8.45$), $t(39) = -3.62$, $p = .001$, $d = 1.13$. There were no other significant differences between any of the conditions pertaining to the percentage of correct details recalled, ps > 0.05.

A main effect of note taking was found for the percentage of *incorrect* details recalled, $F(3, 80) = 8.81$, $p < .001$, $\eta_p^2 = 0.25$. Listeners recalled a significantly higher percentage of incorrect information ($M = 3.99$, $SD = 2.48$) than those who took spidergraph notes ($M = 1.55$, $SD = 1.40$), $t(39) = 3.91$, $p = .000$, $d = 1.21$, linear notes ($M = 1.92$, $SD = 1.51$), $t(40) = 3.30$, $p = .002$, $d = 1.00$, and conventional notes ($M = 1.72$, $SD = 1.35$), $t(39) = 3.67$, $p = .001$, $d = 1.14$. There were no other statistically significant differences between the note taking conditions for the percentage of incorrect details recalled, ps > 0.05.

A main effect of note taking was also found for error rate, $F(3, 80) = 13.11$, $p < .001$, $\eta_p^2 = 0.33$. Listeners provided responses with significantly higher error rates ($M = 25.50$, $SD = 16.07$) than those who took spidergraph notes ($M = 7.43$, $SD = 7.38$), $t(39) = -4.73$, $p = .000$, $d = 1.46$, linear notes ($M = 10.95$, $SD = 9.35$), $t(40) = -3.63$, $p = .001$, $d = 1.10$, and conventional notes ($M = 8.81$, $SD = 6.89$), $t(39) = -4.36$, $p = .000$, $d = 1.35$.

There were no other significant differences between the note taking conditions for error rate in responses, *p*s > 0.05.

The main effect of note taking for details written down in participants' notes was not significant, $F(2, 61) = 1.54$, $p > .05$, $\eta_p^2 = 0.05$. That is, the number of details in participants' notes did not differ between those who took spidergraph, linear, and conventional notes. However, means and standard deviations are also shown in Table 2.

Analysis of Quality and Content of Written Notes. Collapsed across note taking styles, 37 (58%) sets of notes were coded as high quality. Note taking quality was significantly correlated with the percentage of correct details reported in participants' responses, $r = .35$, $p < .01$, and the error rate in participants' responses, $r = -.26$, $p < .05$. That is, higher quality was significantly associated with a higher percentage of correct details, and a lower error rate. Note quality was also significantly correlated with the number of details in their notes, $r = .29$, $p < .05$. Quality was not significantly correlated with the percentage of incorrect details provided in participants' responses, *p*s > .05. Inferential statistics were not carried out to make comparisons between high and low quality given that quality was not manipulated. However, means and associated standard deviations for each dependent measure (as a function of quality) are shown in Table 3.

An analysis of quality within each style of note taking revealed that note quality was significantly correlated with the percentage of correct details reported in participants' responses for those who took linear notes, $r = 0.39$, $p < .05$, and conventional notes, $r = 0.49$, $p < .05$. Quality was also significantly correlated with error rate for those who took linear notes, $r = -0.49$, $p < .05$. Examination of participants' notes revealed a significant correlation between note quality and the number of details found in notes for those who took spidergraph notes, $r = 0.44$, $p < .05$. There were also no other significant correlations between high and low quality note takers within each note taking condition for any other recall measures, ps > 0.05.

Discussion

Given the preliminary support in Experiment 1 indicating note taking is a useful tool to aid in memory performance in an investigative interviewing context, the second experiment sought to examine the effect of three note taking styles on memory recall. Contrary to one of our predictions, there were no statistically significant differences in performance levels across the different note taking styles (i.e., those who took notes using the linear or spidergraph method did not perform significantly better than those who took conventional notes). From a practical point of view, however, the error rate of responses by those who took spidergraph notes was lower, albeit marginally, than the error rate of responses from conventional note takers. Although these differences are not as dramatic as we expected given effect sizes from previous research (e.g., Kiewra et al., 1999), the small differences may have been due to the relatively low level of complexity of our stimuli, or the short period of time spent learning and practicing both linear and spidergraph note taking. It is possible that the differences in performance among note taking conditions will increase if participants are shown longer and more complex witness interviews. Additionally, differences also may be more pronounced if the intensity of training is increased (e.g., training that occurs over a number of days) or if participants are provided more opportunities for practice prior to testing. Having said that, the results also suggests that the marginal reduction in error rate may not be worth the cost of training interviewers to take a particular form of notes because of how well conventional note takers performed (i.e., no training is required). In fact, unlike either organizational style of note taking, conventional note takers recalled a significantly larger percentage of correct details compared to listeners. Future studies that test the bounds of the effectiveness of the note taking styles examined in this study, and with more varied stimuli, so that more definitive policy and practice recommendations can be made with confidence are warranted.

Consistent with Experiment 1 is the finding that the quality of notes was related to performance within some styles of note taking. Within the linear style of note taking, high quality notes was associated with a lower error rate. Within the conventional note taking condition, high quality notes were related to an improvement in the recall of correct pieces of information compared to low quality notes. Low quality notes were not related to poor performance for those in the spidergraph condition. The amount of correct or incorrect details and error rate did not differ between those who took low quality spidergraph notes and those who took high quality spidergraph notes. This latter finding suggests that those who choose to use either a linear or conventional note taking style ought to ensure that high quality notes are recorded; concerns over note quality using the spider graph method appears be of less concern at this juncture.

The second experiment, however, is limited in at least two ways. First, like the first experiment, the interviews were short in duration compared to the length of typical interviews that would be conducted by police officers in actual investigations. Second, the training for each organizational note taking system (i.e., spidergraph and linear) consisted of a single practice session without any feedback. Given that taking notes using the spidergraph or linear method is arguably a new experience for the participants, additional studies should incorporate a more elaborate training program over a number of days that permit numerous practice sessions that contain detailed feedback. It would be interesting to know if more rigorous training will lead to greater recall performance once the spidergraph method become a conventional style for users.

Chapter 4: Experiment 3

Chapters 2 and 3 provided results of experiments examining the *encoding* effects of note taking for details found in a witness' account. As mentioned, *external storage* theory can also explain the benefits of taking notes, whereby note takers have the opportunity to review or study their notes prior to memory testing, allowing them to consolidate the noted information (DiVesta & Gray, 1972; Rickards & Friedman, 1978). Having the opportunity to review notes may facilitate greater memory of information because the review process allows for repeated exposure of the information (Bromage & Mayer, 1986; Middendorf & Macan, 2002), and may act as an aid against the threat of memory deterioration over time and distortion due to subsequent presentation of information (interference theory; Neath & Surprenant, 2003).

The literature described in Chapter 1 is clear that external storage effects of note taking are generally more substantial than encoding effects. However, as mentioned, very few recommendations exist about whether police officers should be taking notes, studying/reviewing them, and whether they are allowed to have access to them during times of memory retrieval, such as report writing and whilst answering questions in court. Based on available literature, reviewing one's notes and subsequently having access to them during such tasks should help them recall higher quality information, resulting in better criminal investigations. The goal of the third experiment is to examine the roles of review and access to notes for participants using conventional and spidergraph styles of note taking.

Method

Design. This study used a 2 (Style: Spidergraph vs. Conventional) x 2 (Review Notes: Yes vs. No) x 2 (Access: Yes vs. No) between participant design. Dependent variables were percent of correct and incorrect information recalled by witnesses during the free recall task, and error rate. Participants' notes were also coded for the percent of correct and incorrect information recorded on paper, and subsequently classified as either *high* or *low* quality.

Power Analysis. In studies assessing the effect of note taking on memory, various effect sizes for the effect of note taking have been reported, usually within the range of medium to large (*d*s between 0.50 and 1.00). Those effect sizes are not directly relevant to the present experiment because they compared note takers to listeners. The present experiment examined the effect of note taking style, review of notes, and access to notes on memory for the details in a witness' account. Effect sizes (d = 1.70) reported by Rickards and Friedman (1978) were used as they examined the effect of note taking (with or without review) on memory. To be conservative, a sample size was chosen that that would allow the detection of a large effect size (d = 1.00 with power = .95; G Power, 14 participants per condition).

Participants. Participants (N = 112) were undergraduate psychology students from Memorial University. The sample consisted of 31 men (M_{age} = 23.48, SD = 3.76) and 81 women (M_{age} = 21.65, SD = 2.78). The average year of study was 3.72 (SD = 1.84).

Materials. Note taking training material was provided to participants who were assigned randomly to the spidergraph note taking condition. Training consisted of an instructional video that was divided into the following sections: a description of the spidergraph note taking style, a demonstration of how to use the note taking style when listening to a free narrative, and an opportunity for participants to practice taking spidergraph notes while listening to a free narrative. The training video for spidergraph note taking lasted 6 minutes and 10 seconds. The spidergraph note taking style was presented to participants as a method of note taking that consisted of major headings located in the middle of a circle. All details pertaining to that heading would be recorded as jot notes located around the circumference of that circle.

An authentic interview transcript of a witness interview formed the basis of the video re-enactment that was used as stimuli. The interview consisted of a police officer questioning a witness about an assault. Although two undergraduates played the roles of the police officer and witness, only the witness was visible in the video. All identifying information found in the actual interview transcript (e.g., names, addresses) was replaced with alternate information. The interview lasted 6 minutes and 50 seconds.

Procedure. The study was conducted in the Psychology and Law Lab at Memorial University. Each participant was greeted at the entrance to the lab and directed to one of four computer terminals. Participants were then asked to read and sign an informed consent form. The experimental instructions were then outlined briefly, and it was verified that the participant understood how to complete their task. Participants were then provided with a pair of headphones, randomly assigned to one of the eight conditions, and instructed to begin the experiment. All participants were provided with paper and a pen. Participants assigned randomly to the spidergraph style were instructed to watch an instructional video that provided them with training on how to take notes in that style. Upon completion of the training video, the researcher ensured that participants in the spidergraph condition completed the practice session utilizing spidergraph notes before moving forward with the experiment. All participants followed the directions. Conventional note takers were instructed to take notes in their preferred way.

Participants listened to the interview, and depending on the condition they were assigned to, they were to either take spidergraph notes or conventional notes. Once the participants finished listening to the witness interview, those assigned randomly to the review condition were given two minutes to *review* their notes. Those assigned randomly to the *no review* condition had their notes taken away by the researcher and were given two minutes to reflect on what they heard. Participants were then asked to respond to a question located in a text document on the computer, which read “Please recall in as much detail as possible what the witness said during the interview”. Participants were asked to type their answers into the word processing software. Those assigned randomly to the *access* condition were permitted to have their notes in front of them and reference them while answering the memory recall question. Those in the *no access* condition were not permitted to have access to their notes while answering the question.

Upon completion of the experiment, each participant received a debriefing form that outlined the purpose of the study. The study took approximately 40 minutes to complete, and participants’ names were recorded so that they would receive a bonus point in their applicable psychology course as compensation for their time. There was no difference in participants' age, gender, or year of study across the eight conditions (ps > .05).

Coding Procedure. Memory for details was measured by coding participant responses for the number of correct and incorrect details reported. A coding guide was created that contained 87 individual idea units. For example, if a participant recalled a *tall man wearing a black shirt* they would receive credit for four idea units (i.e., tall, man, wearing a shirt, the shirt was black). If a participant recalled a *tall man wearing a yellow shirt* they would receive credit for three correct idea units but also one incorrect idea unit (i.e., the shirt was yellow). Each participants' response was coded by identifying how many of the 87 idea units were correct or incorrect. For ease of interpretation, the correct and incorrect details were then converted to percentages. A measure of error rate was also created by dividing the total number of *incorrect* details by the total number of details reported, and then multiplying that value by 100.

The notes taken by participants were also coded for correct details pertaining to the 87 idea units. Notes were also assessed for the presence of incorrect details. In addition, each set of notes was coded as either "high quality" (i.e., legible, organized, and contained sufficient detail about the witness' account), or "low quality" (i.e., difficult to read, not organized, and contained very little detail).

Inter-rater Reliability. Coding agreement of the variables was assessed by having an independent researcher code the entire sample. The independent coder was provided with a 1-hr training session that consisted of the structure and content of the coding guide as well as the practical aspects of coding the participants' responses. Additionally, the coder participated in a practice session that covered the coding of two interviews before beginning to code the actual interviews. Any confusions pertaining to the task were resolved before inter-rater reliability commenced. Inter-rater reliability was assessed with Kappa (κ). Kappa revealed acceptable agreement ratings of κ = .71, 0.75, 0.72, and 0.73 for the correct details recorded in participants' notes, correct details found in participants' responses, incorrect details found in participants' responses, and the quality of participants' notes, respectively.

Results

A 2 x 2 x 2 between-participants factorial multivariate analysis of variance (MANOVA) was conducted to assess differences among note taking style, review of notes, and access to notes on a linear combination of measures of memory performance (i.e., percent of correct and incorrect details reported and error rate). The data were checked to ensure the statistical assumptions associated with conducting a MANOVA were met. The assumption of independence of observations was accounted for by random assignment to the three independent variables. Sample size was deemed to be acceptable as there were more cases in each cell than dependent variables and an equal number of cases within each cell. Correlations (ranging from r = -.18 to -.79) between dependent variables reflected the fact that no violation of the assumption of multicollinearity. Box's M test for quality of variance-covariance matrices was statistically significant at the .000 level, indicating a violation of this assumption. It is worth nothing that Tabachnick and Fidell (2007) suggest that Box's M test is notoriously sensitive and strict therefore it is recommended to disregard its outcome when sample sizes are equal because robustness of significance tests are expected.

The following sections describe the multivariate main effects for the independent variables examined (i.e., note taking style, review, and access). Each multivariate main effect is then followed by a description of the subsequent univariate analyses of variance corresponding to each dependent variable (i.e., the performance measures, and findings are presented in accompanying tables). Descriptive statistics for each combination of variables are shown in Table 4. Correlations between note quality and the measures of memory performance are also described.

Multivariate and Univariate Effects. The multivariate result showed a significant main effect for note taking style, Wilks' $\Lambda = .88$, $F\,(3, 102) = 4.65$, $p < .05$, multivariate $\eta_p^2 = .12$[4], indicating a difference in memory performance between participants who took conventional and spidergraph notes. Subsequent univariate analyses of variance, using Bonferroni criteria to correct for multiple comparisons (i.e., .05 divided by 3, the number of dependent variables), revealed a significantly smaller percentage of incorrect details reported by participants who took conventional notes compared to those who took spidergraph notes. There was no statistically significant univariate effect of note taking style for the percentage of correct details reported or error rate. The means, standard deviations, and effect sizes for univariate effects of note taking style are shown in Table 5.

[4] η_p^2 or partial eta squared indicates the proportion of variance of the dependent variable that is explained by the independent variable. According to Cohen (1988), .01 is approximately equal to a small effect, .06 is approximately equal to a medium effect, and .138 is approximately equal to a large effect.

There was no statistically significant multivariate effect for the main effect of *review of notes*, $p > .05$. However, means, standard deviations, and effect sizes for univariate effects of note taking review are shown in Table 6.

A significant main effect for access to notes was found, Wilks' $\Lambda = .77$, F (3, 102) = 9.97, $p < .001$, multivariate $\eta_p^2 = .23$, indicating a difference in performance between participants who had access to their notes while providing their memory recall and those who were not permitted access to their notes during memory recall. Subsequent univariate analyses of variance, again using Bonferroni correction, showed significant univariate effects (means, standard deviations, and effect sizes for univariate effects of note taking access are shown in Table 7). Specifically, participants who had access to their notes recalled a significantly larger percentage of correct details, a significantly smaller percentage of incorrect details, and their error rate was significantly lower than those who did not have access to their notes during recall.

A significant review-by-access interaction effect was found, Wilks' $\Lambda = .88$, F (3, 102) = 4.58, $p < .05$, multivariate $\eta_p^2 = .12$. Follow-up univariate analyses of variance showed a significant interaction effect on the percentage of incorrect information, F (1, 104) = 12.57, $p < .001$, $\eta_p^2 = .11$, indicating that participants who had access to their notes reported a smaller percentage of incorrect details than those who did not have access to their notes. However, in the no access condition, participants who were not permitted to review their notes prior to testing reported a significantly higher percentage of incorrect details compared to those who were permitted to review their notes prior to testing. Additionally, a significant interaction effect was found for error rate, F (1, 104) =

12.39, $p < .001$, $\eta_p^2 = .11$. Participants who had access to their notes had a lower error rate than those that did not have access to their notes during recall, but error rate was significantly higher when participants did not have the opportunity to review their notes (review/no access: $M = 5.60$, $SD = 6.04$; no review/no access: $M = 13.41$, $SD = 12.08$).

Analysis of Quality and Content of Written Notes. Collapsed across both note taking styles, 57 (51%) sets of notes were coded as high quality. Note taking quality was significantly correlated with the percentage of correct details reported in participants responses, $r = 0.26$, $p < .05$, and the number of correct details written down in their notes, $r = 0.39$, $p < .001$. That is, better quality notes were associated with more correct recall. Note taking quality was also significantly correlated with note taking style, $r = 0.19$, $p < .05$, where higher quality was related to the spidergraph note taking method. Notes were also assessed for the presence of incorrect details; none were present. Quality was not significantly correlated with percent of incorrect details recalled or error rate, *p*s > .05. Inferential statistics were not carried out to make comparisons between high and low quality given that quality was not manipulated. Means and associated standard deviations for each dependent measure (as a function of note-taking quality) are shown in Table 8.

Discussion

Experiment 3 sought to not only test the effect note taking *styles* on memory recall, but to also examine the effect of reviewing notes prior to a memory recall task as well as having access to notes during a memory recall task. Unlike the first two experiments, which only examined encoding effects, Experiment 3 investigated encoding and external storage effects or note taking, whereby some participants had the opportunity to study and refer back to their notes at the time of testing. Similar to our results in Experiment 2, there were few significant differences between conventional note takers and spidergraph note takers, except for fewer incorrect details reported by conventional note takers compared to spider graph note takers.

The inability for the spidergraph method of note taking to yield better memorial performance compared to the conventional method suggests an issue of multi-tasking or divided attention. It is possible that the task of learning and executing a novel style of note taking utilized too many cognitive resources, thus reducing the encoding effect of note taking. Contrary to our prediction, those who reviewed their notes did not perform any better on the memory recall task than those who did not review their notes.

In support of another prediction, those who had access to their notes during testing performed better on all three measures (percent correct, incorrect, and error rate) compared to those who did not have access to their notes. These results, unlike results from first two experiments that investigated only simple encoding effects, provided insights into the external storage effect of note taking. Superior memory performance demonstrated by those with access to their notes supports a wealth of research in the educational literature that has examined external storage effects of note taking (see Kobayashi, 2006). This effect is likely due to the fact that having access to notes at time of memory recall allowed for repeated and constant exposure of the information (Bromage & Mayer, 1986; Middendorf & Macan, 2002), and may have acted as an aid against the threat of memory deterioration and distortion (interference theory; Neath & Surprenant, 2003).

Analyses of interactions revealed that when participants did not have access to their notes, those who did not have the opportunity for review produced significantly more errors compared to those who did review their notes. There is little theoretical basis to explain this finding, however, one possible explanation is that those who reviewed their notes were able to draw upon the review process at the time of testing, whereas those not afforded a review period could only rely upon the initial presentation of the witness interview. The opportunity for review clearly yielded better performance when access was not granted. The external storage effects of note taking also explain this finding, whereby those who reviewed their notes were arguably more actively engaged with the to-be-remembered material and likely experienced deeper levels of understanding (Bohay, Blakely, Tamplin, & Radvansky, 2011).

Additionally, although not significant, another interesting finding was that note takers who did not have the opportunity to review their notes, but had access during testing, performed better (i.e., produced responses with a lower error rate) compared to note takers who reviewed their notes and also had access during testing. This is surprising as it is natural to predict that those who had a review period with opportunity to access would perform the best. One potential explanation for this counter-intuitive finding is that those who reviewed their notes may have been over confident in their memory recall ability, and may have relied less on their notes during testing, compared to those who did not have a review period. Notes contained very accurate information, which if relied upon only by those who did not review their notes, could explain the better performance at time of testing.

As in Experiment 1 and 2, high quality notes were related to more correct recall regardless of style of note taking. Although quality was measured as a quasi-experimental variable (i.e., it was not manipulated) in the current program of research, these results still provide an interesting insight into the effect note quality can have on memory. This finding contributes to Kiewra's (1989) meta-analysis which demonstrated positive note taking effects in experiments comparing note takers who took part in training programs or who received verbal instructions on how to take notes to those who did not receive any training or instructions to improve quality of notes.

The third experiment is limited by at least one concern. Participants were only given two minutes to review their notes prior to testing. Although they were informed of this time limit, it is possible that two minutes was not a sufficient amount of time to produce enhanced memory recall, which may explain why review did not increase memory retrieval any more than simple encoding effects. Research is required to explore a variety of review strategies before outright dismissing the value of reviewing notes. For example, future experiments should investigate types of review (i.e., summarizing one's notes verbally) and length of review periods.

Chapter 5: General Discussion

The ability of investigative interviewers to comprehend, remember, and utilize information that is provided by witnesses can ultimately lead to the successful resolution of a crime. Although note-taking has been shown to be an effective memory-enhancing tool in the education setting, the effectiveness of note taking as a memory-enhancing tool has never been examined in an investigative interview setting. Over the course of three studies the applicability of note-taking in the investigative interviewing context was tested. Specifically, the following three provisional conclusions emerged: (1) Training police officers receive in spidergraph note taking may be somewhat misguided; the evidence from the current experiments suggest that police officers should take conventional notes instead of using the spidergraph method, (2) reviewing and access to notes should be a priority for police officers whilst writing reports or responding to questions in court, and (3) officers should ensure the quality of their notes is high. Although more research is needed to test the bounds of note taking in an investigative interview setting, several practical recommendations can be made to improve the memory of police officers who are involved at any stage of the investigative interviewing process.

The magnitude of the difference in performance levels between note takers and listeners in the current research is comparable to effect sizes seen in literature addressing the encoding effects of note taking behaviour in other domains. Specifically, participants in the first two experiments did not have the opportunity to review their notes; thus, memory performance was enhanced by the act of simply taking notes, without having access to them or reviewing prior to being tested. Ryan (1982), Henk and Stahl (1985), and Kobayashi (2005) found effect sizes that were small, but positive (*d* = 0.22, 0.34, and 0.22, respectively), which are similar to the effect size seen in the current experiment (*d* = 0.14). Theoretically, unlike listeners, memory enhancement for the note takers could be attributed to the possibility that they may have paid greater attention to the details provided in the witness' account, were better able to organize the material mentally, or were able to relate details in the witness' account to past knowledge, thereby making it more memorable (Craik & Lockhart, 1972; Einstein et al., 1985; Frase, 1970). Regardless of which underlying theory best explains the positive impact note taking had on memory in the current research, findings from these three studies provided support for police organizations to recommend that their members take notes in all interviews with victims, witnesses, and suspects.

Despite the intuitive nature of this recommendation, however, the results from the current research demonstrated that the efficacy of note taking as a memory-enhancing tool was not greater for organizational methods compared to conventional note taking practices. The current research revealed very little benefit for note takers who were trained in and implemented an organizational note taking system (i.e., the spidergraph method) over conventional note takers, with the exception of the finding that those who took spidergraph notes gave responses with a marginally lower error rate. In fact, conventional note takers recalled significantly more information compared to those who took notes using an organizational style. Although based on a single study, this finding potentially has important implications for current police note taking practices in investigative interviews. Although more research is needed on the role of spidergraph note taking as a memory enhancing tool – especially under circumstances whereby note takers have more opportunity to perfect this new skill – the findings suggest that investigative interview trainers should be cautious in teaching this style of note taking.

It is not overly surprising that note takers in the current study who utilized an organizational style of note taking did not outperform conventional note takers. Unlike previous studies examining organizational note taking, the current study did not use framework notes. Participants in the current study, although trained to take organizational notes, were not provided with pre-determined headings and sub-headings to guide their note taking process. Unlike educational contexts, police officers are not in a position to predict the content of a witness' account because they are blind to the content of the forthcoming account; and therefore, the current experiments did not use note taking methods that require a pre-planning phase to create framework notes. Studies in the educational domain have examined organizational note taking styles using matrix and outline notes that provided students with the main points of lecture material in the form of headings. According to Mayer (1984), providing students with headings and sub-headings allows them to form internal connections between concepts. Unlike the results presented in the current series of studies, there are a number of experiments in the educational domain that have found a large effect for the difference between conventional and organizational note taking styles. Although the current experiments use an organized style of note taking, it may not be a fair comparison to organizational methods in the literature given participants did not experience the same preparation of framework notes.

Kiewra and his colleagues (1995), in their first experiment, assigned 54 students to either take notes using a matrix framework, outline linear framework, or conventional style while listening to a videotaped lecture. Following a one-week delay, students completed a free-recall test of memory for the lecture material. Results showed performance was best for outline linear note takers, with little difference in memory recall between conventional and matrix-style note takers. Kiewra and his colleagues (1995) explained that the matrix style of note taking may not have facilitated enhanced recall because the framework provided in their Experiment 1 contained a reduced number of cells available for note taking, thus reducing the quantity of notes students could take. In a previous study by Kiewra and colleagues (1991), note taking quantity was more equally matched for matrix and outline frameworks. When participants were provided with the same number of cells for the matrix and outline note taking tasks (i.e., 56 and 57 cells, respectively), they performed better on a cued-recall task compared to participants who took notes using a conventional style. These findings are in line with earlier work that showed reviewing organized notes led to the best performance on a memory recall test (Kiewra et al., 1988).

As mentioned, the current series of studies does not support the above-mentioned findings that memory recall will be enhanced if note takers utilize an organizational method of note taking. Those who took notes using the spidergraph or linear method did not out perform those who took conventional notes. In fact, the results from Experiment 2 showed that conventional note takers recalled significantly more correct details compared to either organizational style. Experiment 3 revealed that conventional note takers reported significantly fewer incorrect details than those who use spidergraph and linear styles. There are two potential explanations for the lack of effect demonstrated by the spidergraph and linear styles. First, it is possible that the task of learning and applying a new method of note taking was particularly challenging for participants; thus, taking up many cognitive resources that could not otherwise be allocated to encoding the witness' account. Second, participants who were taught to take notes using the spidergraph and linear method may not have been afforded enough practice with the new technique prior to testing (see Peverly et al., 2007). Specifically, participants watched a video approximately 5 minutes long to learn about the new note taking style, but were only given one opportunity to practice the new technique.

The poor performance demonstrated by linear and spidergraph note takers may be explained by theory pertaining to divided attention. Participants in the current research who were taught to take notes with the spidergraph or linear method were asked to use this method of note taking while listening to an interview with a witness to crime. It is certainly possible that the participants' attention could not be adequately directed towards the note taking task and witness' account due to the complexity of the organizational note taking method that they were trying to follow. For example, participants in the spidergraph condition may have been focusing their attention on the process of identifying topics to place inside circles, or worrying about the note taking procedure in general, and at the same time attempting to encode the witness' account and take notes. A wealth of research has identified divided attention at the encoding phase of memory as a threat to successful memory retrieval (Baddeley, Lewis, Eldridge, & Thomson, 1984;

Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Naveh-Benjamin, Craik, Guez, & Dori, 1998; Naveh-Benjamin, Guez, Hara, Brubaker, & Lowenschuss-Erlich, 2014; Pashler, 1994; Wickens, 1991).

Studies investigating the role of divided attention in memory retrieval typically provide participants with material (e.g., word lists, information in a particular temporal order, or spatial information; see Naveh-Benjamin, 1990) to be remembered. While encoding, attention is either devoted fully to the TBR material, or is divided by the presentation of a secondary task. For example, Naveh-Benjamin and colleages (2014) found performance on a memory recognition test was significantly better when participants' full attention was devoted to the task of encoding a list of words (54%) compared to a condition that required participants to take part in a visual continuous choice reaction task (VCRT) while encoding the TBR words (33%). The VCRT had participants having to press a key that corresponded to an asterisk that appeared in one of four boxes on a computer screen. Participants were instructed to carry out this task as accurately as possible while the TBR words were being presented simultaneously. One explanation for the decrease in performance on the memory task when VCRT was used as a distraction at encoding is that there are fewer cognitive resources available for the processing of TBR information because participants must engage in and pay attention to the secondary task.

The findings from the second and third experiment in the current research provide support for the theory of divided attention. The lack of enhanced memory recall exhibited by those who took spidergraph and linear notes may have been a result of cognitive resources being exhausted at the time of encoding purely because of the act of taking notes using a very novel style of note taking. It is likely that few cognitive resources were devoted to encoding of information found in the witness' account. Unlike the current series of studies, the experiments conducted by Naveh-Benjamin and colleages (2014) ensured the secondary task was utilizing a separate modality (visual) than the one required for the encoding of information (auditory). In the current research, taking notes using the spidergraph or linear method required visual attention, as did paying attention to the witness interview. Therefore, it is not surprising that we did not find an impressive level of performance on the memory task by the organizational note takers; given that they were probably exposed to modality-specific interference (i.e., competing attention demands in the visual domain, see Allport, Antonis, & Reynolds, 1972). It is also certainly possible that the headings used in the Spidergraph style of note taking do not facilitate similar levels of organization compared to other organizational methods (e.g., the matrix).

As mentioned, the act of taking notes using the spidergraph or linear method may have been more of a familiar activity to participants had they received more extensive practice sessions. Social facilitation research suggests that performance may be hindered if someone is required to use a non-dominant behaviour (i.e., a behaviour that does not come naturally, such as taking notes using the spidergraph or linear method; Zajonc, 1965). Based on research on social facilitation, it seems that the most likely way to see memory enhancing benefits facilitated by organizational styles of note taking is to convert the non-dominant behaviour into a dominant behaviour first. Future research should address this possible explanation by varying the volume of practice for each organizational style of note taking, and uncovering the adequate amount of training and practice required. It is possible that the more comfortable note takers become with the spidergraph or linear methods of note taking (i.e., organized note-taking), the likelihood of negative consequences of performing secondary tasks at the encoding stage of memory retrieval will be reduced; that is, the full benefits of using an organized note-taking system may be realized.

Even with the general increase in performance on a memory recall task observed for note takers in the current research, there were considerable differences in performance depending on whether participants had access to their notes or not during the retrieval phase. Unlike the first two experiments, which only examined encoding effects of note taking, the third experiment showed that note takers (regardless of style of note taking) who had access to their notes during memory retrieval recalled significantly more details, reported fewer incorrect details, and provided responses with a significantly lower error rate compared to note takers who did not have access to their notes. The increase in performance under the condition of access to notes during retrieval supports a wealth of research that has examined external storage effects of note taking (see Kobayashi, 2006).

One interesting finding was the significant interaction between access and review in the third Experiment. When participants did not have access to their notes, those who also did not have the opportunity for review produced significantly more errors compared to those that did review their notes. One possible explanation, drawing upon the external storage literature, is that the review period provided note takers with an additional opportunity (i.e., repeated exposure; Bromage & Mayer, 1986; Middendorf & Macan, 2002) to consolidate the noted material. In the absence of an opportunity to access notes, those who reviewed their notes had the advantage of additional exposure to the to-be-remembered information, which likely contributed to their enhanced performance.

It is also unsurprising that having access to notes in the current research allowed note takers to benefit from the opportunity to review notes at time of testing, and also consolidate details reported in the witness' account, reducing the likelihood of memory deterioration over time (DiVesta & Gray, 1972; Rickards & Friedman, 1978). It was surprising, however, that simply reviewing notes (with or without access at time of testing), did not facilitate better memory recall than those who did not review their notes. The most likely explanation for the lack of effect for review in the current research is that the review period was insufficient. In hindsight, it is expected that note takers who review their notes for a longer amount of time might outperform note takers who do not get the opportunity to review their notes. Additionally, having participants summarize their notes aloud would ensure that they took part in the review period. This is an area that should be investigated by future research. Notwithstanding the lack of effect of review, these results have important implications for investigative interviewing practices. Given the positive impact access had on memory recall, we advise police officers to ensure that they have access to their notes during times when their memory for the witness' account is being recalled or questioned (i.e., during report writing or while answering questions in court). We also encourage police officers to review their notes. Our results suggest that if access to notes is not possible at time of memory recall, a lack of review may lead to the production of inaccurate details, which could ultimately impact the quality of an investigative report.

Although taking notes certainly had an effect on participants' memory for details in the witness' account, the quality of their notes were also of importance. High quality notes were related to recalling a greater number of correct details, fewer incorrect details, and lower error rates in responses. According to Kiewra (1989), those who take low quality notes are not benefitting fully from the encoding function of note taking, which may explain why the low quality note takers in the current research did not perform as well as those who recorded high quality notes. In his review of 57 studies, Kobayashi (2005) examined quality of notes as a moderator variable (measured by presence of training program, verbal instructions on how to take notes, etc.) and found that quality of notes was significantly associated with variations in effect size. Although this is an interesting finding, it should be taken with caution as quality was not a manipulated variable, but was measured in a quasi-experimental way.

Within the conventional and linear styles of note taking, quality was related to performance. That is, performance worsened if participants' notes were classified as low quality compared to others that were considered to be high quality. However, spidergraph note takers did not experience such hindrance on performance even if the quality of their notes was classified as low. Although there is no theoretical basis to explain why the spidergraph style of note taking protected against poor performance any more than the linear style should have, we speculate that the highly visual nature of a set of spidergraph notes facilitated better memory for the witness' account.

Practical Implications

The results of our three experiments provide, albeit provisionally, insights into the effect of note taking in an investigative interview setting. These findings provide support for a number of recommendations. First, until more research is conducted on the effect of training people to use organized note systems, it may be productive to advise interviewers to use conventional note taking practices. The results of our second and third Experiments show that conventional note takers recalled a significantly greater amount of correct details compared to those who took linear or spidergraph note taking styles. We suspect that asking participants to take notes using a new organizational style of note taking added to the cognitive load of the task, which may have impeded their memory performance. Second, police officers are urged to access their notes while taking part in activities requiring their recall of the witness' account, such as writing structured summaries of the interviews, report writing, or providing testimony in court. Finally, because performance suffered as a function of quality for those who took conventional notes, it would be useful to inform, or train, conventional note takers to make sure that they take good quality notes.

Limitations

There are at least three limitations concerning the present series of experiments. First, given the early stages of this program of research, very basic comparisons were made between conditions. This limits the generalizability to primary investigative interviewers at this time. However, given the encouraging findings in the present research, future experiments should be conducted using more ecologically valid designs.

Specifically, future studies should be conducted whereby police officers carry out an interview with a standardized witness while either taking notes or listening. Second, the interviews (TBR material) were short in duration compared to the length of typical interviews that would be conducted by police officers in actual investigations. Third, the training for each organizational note taking system (i.e., spidergraph and linear) consisted of a single practice session without any feedback. Given that taking notes using the spidergraph or linear method is arguably a new experience for the participants, additional studies should incorporate a more elaborate training program over a number of days that permit numerous practice sessions that contain detailed feedback. We predict that more rigorous training will lead to greater recall performance.

Future Research

Notwithstanding the improvement in memory for note takers over listeners, there is still a wealth of research to be conducted examining the limits of the note taking effect in an investigative interview setting. As mentioned, the current methodology lacks a degree of ecological validity as it pertains to the role of a primary interviewer (i.e., the note-takers did not have to engage in other important interviewing behaviours such as asking questions, identifying topics to explore, managing interpersonal dynamics), but the results provide the first insights into the effect of note taking on memory for details in a witness' account for other investigative interviewing tasks. The findings open up possibilities about whether or not note taking may benefit a primary interviewer who is engaged in a more dynamic interpersonal process. Future studies that test the bounds of the effect of note taking are needed (e.g., whereby note takers are also required to formulate questions while listening to a witness' account, formulating follow up questions, having the ability to access their notes, having an opportunity to study their notes).

In addition, future research should address the main limitation of Experiment 3, whereby participants were asked to review their notes independently. Future studies should test the bounds of the reviewing process and certainly include a verbal summarization task. Verbal summaries would ensure that participants are focusing and reviewing their notes prior to the memory task, and have been shown in some research to improve memory beyond simply reading information (MacLeod, Gopie, Hourihan, Neary, & Ozubko, 2010). Summarizing aloud also would be a task that has more ecological validity, given that officers are often taught to summarize their notes aloud during an interview to ensure they have not made any errors, or to offer an opportunity to the witness to add or change anything that the officer has repeated back.

Concluding Thoughts

Assuming that future research supports our findings about the effect of note taking on memory for details, research examining the impact of the note taking process on information provision by interviewees is also warranted. From a practical perspective, the current research raises concerns about training police officers receive in the spidergraph method of note taking. Results suggest that police officers should take conventional notes instead of using the spidergraph method in order to avoid negative consequences of multi-tasking. However, we predict that *intensive* training in the spidergraph method may reduce the likelihood of cognitive resources being depleted if the novel technique can become more of a routine task for officers. As it stands, the data from the three experiments raise interesting questions about the extent to which note taking may be able to enhance memory for details across a spectrum of interviewing tasks, and ultimately improve the quality of criminal investigations.

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Table 1

Means and Standard Deviations for Measures of Performance in Experiment 1

Measure of Performance	Note Takers (n = 20)	Listeners (n = 20)	High Quality Note Takers (n = 11)	Low Quality Note Takers (n = 9)
% Correct	38.65 (7.44)	29.43 (11.99)	42.45 (6.48)	34.01 (5.90)
% Incorrect	2.47 (1.96)	3.47 (1.80)	2.60 (1.78)	2.31 (2.25)
Error Rate	6.21 (4.73)	12.49 (6.09)	6.03 (3.92)	6.44 (5.82)
% Notes Correct	44.95 (8.58)	--	47.58 (7.88)	41.94 (8.73)

Note. Each mean (except for error rate) was calculated by dividing the raw number of idea units recalled by 115 (the total number of idea units) and then multiplied by 100 to obtain a percentage. Error rate was also created by dividing the total number of incorrect details by the total number of details reported, and then multiplied by 100.

Table 2

Descriptive Data for Performance as a Function of Note Taking Condition in Experiment 2

Measure of Performance	Listeners (n = 20)	Spidergraph (n = 21)	Linear (n = 22)	Conventional (n = 21)
% Correct	28.11 (8.45)	32.03 (8.40)	33.29 (10.42)	37.88 (8.81)
% Incorrect	3.99 (2.48)	1.55 (1.40)	1.92 (1.51)	1.72 (1.35)
Error Rate	25.50 (16.07)	7.43 (7.38)	10.95 (9.35)	8.81 (6.89)
% Correct Notes	--	33.14 (10.26)	38.41 (9.53)	37.58 (11.71)

Note. Each mean (except for error rate) was calculated by dividing the raw number of idea units recalled by either 87 or 69 (the total number of idea units for each type of stimuli) and then multiplied by 100 to obtain a percentage. Error rate was also created by dividing the total number of *incorrect* details by the total number of details reported, and then multiplied by 100.

Table 3

Descriptive Data for Performance for each Note Taking System as a Function of Quality in Experiment 2

	Note Taking System					
	Spidergraph		Linear		Conventional	
Measure of Performance	High Quality (n = 12)	Low Quality (n = 9)	High Quality (n = 12)	Low Quality (n = 10)	High Quality (n = 13)	Low Quality (n = 8)
% Correct	32.89 (8.70)	30.89 (8.35)	37.00 (10.82)	28.85 (8.37)	41.23 (8.58)	32.43 (6.41)
% Incorrect	1.70 (1.22)	1.34 (1.67)	1.49 (1.41)	2.45 (1.52)	1.59 (1.21)	1.91 (1.62)
Error rate	7.67 (6.24)	7.11 (7.89)	6.83 (6.30)	15.90 (10.28)	7.69 (5.55)	10.62 (8.75)
% Notes Correct	36.99 (8.81)	28.03 (10.25)	40.84 (9.98)	35.49 (8.53)	39.41 (10.27)	34.64 (13.95)

Note. Each mean (except for error rate) was calculated by dividing the raw number of idea units recalled by either 87 or 69 (the total number of idea units for each type of stimuli) and then multiplied by 100 to obtain a percentage. Error rate was also created by dividing the total number of incorrect details by the total number of details reported, and then multiplied by 100.

Table 4

Means and Standard Deviations for Performance Measures as a Function of Condition in Experiment #3

	Performance Measure		
Condition	% Correct	% Incorrect	Error Rate
Conventional / No Review / Access	43.84 (9.34)	0.66 (0.87)	1.67 (2.29)
Conventional / Review / No Access	31.28 (9.02)	0.98 (1.09)	2.97 (3.21)
Conventional / Review / Access	38.83 (14.14)	1.23 (0.71)	3.23 (1.89)
Spidergraph / No Review / Access	34.89 (10.77)	1.81 (1.41)	5.58 (4.85)
Spidergraph / Review / Access	36.54 (10.55)	2.87 (2.15)	8.05 (6.63)
Spidergraph / Review / No Access	30.95 (8.47)	2.55 (2.22)	8.23 (7.12)
Spidergraph / No Review / No Access	22.74 (2.96)	3.28 (2.42)	12.01 (7.72)
Conventional / No Review / No Access	26.93 (12.43)	3.45 (2.51)	14.82 (15.46)

Note. Combinations of conditions are arranged from lowest to highest error rate. Each mean (except for error rate) was calculated by dividing the raw number of idea units recalled by 87 (the total number of idea units) and then multiplied by 100 to obtain a percentage. Error rate was calculated as the number of errors made divided by the total number of details reported and then multiplied by 100.

Table 5

Univariate Effects for Note Taking Style in Experiment #3 (Bonferroni adjusted α =.016)

Dependent Variable	*F*	*p*	Note Taking Style Condition	*M*	95% *CI*	Partial η^2
% Correct	4.04	0.047	Conventional	35.22	[32.11, 38.33]	0.037
			Spidergraph	31.28	[28.17, 34.39]	
% Incorrect *	9.39	0.003	Conventional	1.37	[0.92, 1.83]	0.083
			Spidergraph	2.28	[1.83, 2.74]	
Error Rate	4.01	0.048	Conventional	5.67	[3.72, 7.63]	0.037
			Spidergraph	8.46	[6.51, 10.43]	

* $p < .016$

Table 6

Univariate Effects for Note Taking Review in Experiment #3 (Bonferroni adjusted α *=.016)*

Dependent Variable	*F*	*p*	Note Taking Review Condition	*M*	95% *CI*	Partial η^2
% Correct	1.37	0.24	Review	31.11	[28.44, 33.77]	0.01
			No Review	31.39	[28.73, 34.06]	
% Incorrect	1.30	0.26	Review	1.66	[1.22, 2.09]	0.01
			No Review	2.00	[1.56, 2.44]	
Error Rate	4.31	0.04	Review	5.62	[3.66, 7.58]	0.04
			No Review	8.51	[6.56, 10.47]	

* $p < .016$

Table 7

Univariate Effects for Note Taking Access in Experiment #3 (Bonferroni adjusted α *=.016)*

Dependent Variable	*F*	*p*	Note Taking Access Condition	*M*	95% *CI*	Partial η^2
% Correct *	28.97	0.00	Access	32.18	[29.52, 34.84]	0.22
			No Access	30.32	[27.66, 32.98]	
% Incorrect *	7.32	0.008	Access	1.43	[0.99, 1.86]	0.06
			No Access	2.23	[1.76, 2.67]	
Error Rate *	12.19	0.001	Access	4.63	[2.67, 6.59]	0.10
			No Access	9.51	[7.55, 11.46]	

* $p < .016$

Table 8

Means and Standard Deviations for each Performance Measure as a Function of Quality in Experiment 3

Measure of Performance	High Quality Note Takers (n = 57)	Low Quality Note Takers (n = 55)
% Correct	36.28 (11.67	30.12 (11.32)
% Incorrect	2.07 (2.08)	2.13 (1.97)
Error Rate	6.31 (6.85)	7.86 (9.69)
% Notes Correct	40.29 (11.01)	31.38 (10.15)