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An Observational Study of Skilled Memory in Waitresses

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SUMMARY

A two-phase observational study was done on skilled waitresses as they served lunch orders in a Manhattan restaurant. Three months of participant observation provided a job description which characterized the skilled use of memory by waitresses. A second set of observations tracked the handling of orders for five confederate customers, and looked at ways in which waitresses had to reorganize information in order to do their job quickly and accurately. The data revealed that waitresses sort-order information into different organizational configurations to match locations in the restaurant, and that they adaptively utilized these configurations in the flow of their activity.

Skilled memory is a term used by Chase and Ericsson (1981) to refer to a memory system developed after lengthy practice, in which storage and retrieval operations are considerably speeded up, and working memory capacity for a particular knowledge base is increased. Several lines of research converge in this model, which owes much to the information processing view of humans as limited capacity symbol manipulators (Siegler, 1983).

Working memory

One line of research is the work of Baddeley and Hitch (1974) and Baddeley (1981), who used the term 'working memory' to incorporate the notion of a workspace area in the memory system with more general notions of the role of temporary storage in information processing. Baddeley described working memory as a system with three components or subsystems: the central executive, the articulatory loop, and the visuospatial scratch pad. The articulatory loop resembled a tape loop of limited duration and was used for verbal material. The visuospatial scratch pad was used to visualize spatial information. The central executive was originally described (Baddeley and Hitch, 1974) as the component responsible for control processes, decision-making, encoding and storage. Baddeley (1981) subsequently said that the central executive is more like an attentional system, and 'any model of working memory also has to be a model of attention'.

Baddeley's work, as Ericsson (1985) has pointed out, is in agreement with Newell and Simon's work on information processing which posits different kinds of memory

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stores, with cognitive processes mediating storage and recall. In spite of implicit links between Baddeley's central executive and long-term storage, which would be necessary to regulate attention and perform encoding operations, the model of working memory is one of a limited capacity system for temporary storage and processing. Chase and Ericsson therefore chose the terms 'skilled memory' in order to avoid the connotations of limited capacity carried by the term 'working memory' (Chase and Ericsson, 1981).

Expert memory

Another line of research is the work done on the superior memory of experts for information in their domain of experience. For example, Chase and Simon (1973) showed that master chess players, as opposed to less experienced players, had superior memories for chess positions after very brief periods of exposure. This has important implications for characterizations of a temporary storage system in memory since, as Chase and Ericsson (1982) later pointed out, 'chess expertise depends in part on fast access pattern recognition, because patterns are associated with procedural knowledge about strategies and correct lines of play'.

Exceptional memory

In addition to experts' memories for familiar material, Ericsson and Chase (1982) also drew upon reports of exceptional memory, in which skilled mnemonists showed superior recall for unfamiliar material. For example, Luria's famous mnemonist Shereshevskii could reproduce a 50-digit matrix after examining it for 3 minutes (Luria, 1968).

Skilled memory

For Chase and Ericsson, the major features of skilled memory are rapid, skilful encoding, which in turn allows rapid efficient use of long-term memory. In their model, temporary knowledge structures, consisting of skilfully encoded familiar information, are built up through practice in long-term memory. Information contained in these structures is immediately accessible to the memory expert because of built-in retrieval cues in the encoded information. This is what allows the capacity limitations of short-term, or working memory, to be bypassed. Acquired memory skill, said Ericsson and Chase (1982), is comparable to the superior memory of experts such as chess masters, for material in their domain of expertise, as well as the exceptional memories of skilled mnemonists.

Chase and Ericsson based their laboratory-derived model on the performance of a subject who, after lengthy practice, increased his digit span to 84 digits. The subject was a runner who possessed a well-learned body of information on running times; and he used this information to encode the digits. A second subject used the same method, increased his digit span to 96 digits, and was also able, with practice, to match Shereshevskii's performance with a digit matrix (Ericsson and Chase, 1982).

The model was subsequently applied to a waiter named Conrad, who could remember up to 20 meal orders without writing them down (Ericsson and Polson, 1988) and to cocktail waitresses who remembered large numbers of drink orders (Bennett, 1983). These studies found that encoding strategies similar to the method of loci were used; that is, meals and drinks were associated in memory either with the customer who ordered them or the customer's location. Presumably, well-learned knowledge of a bar or restaurant's physical layout, as well as knowledge of menu items or drinks, would be the bases for encoded information in the temporary knowledge structures of the skilled waiters and waitresses. In addition to the method of loci, Ericsson and Polson found that their waiter also used other strategies for different parts of the meal orders. For example, he clustered potatoes and rice into the category of starches. He formed words or acronyms from the first letters of different salad dressings. Although the waiter's overall recall of meals was configural, that is, based on customer seating at a table, different components of the meals were being regrouped in various ways. Bennett reported that waitresses, although they associated drinks with customers, had, in order to obtain the drinks, to regroup them into the bartender's calling order. For example, beers, wines, gin drinks, whiskey drinks, etc. had to be grouped. In the above studies, although these grouping phenomena were reported, the focus was on the number of items recalled by the waiter and waitresses. The number of items recalled provided evidence for the use of skilled memory.

Regrouping information in skilled memory

The use of regrouping strategies, however, warrants more attention. Scribner, Gauvain, and Fahrmeier (1984) studied the job performance of product assembly workers in a dairy. These workers would read several orders for dairy products from a centrally located load-out order form. Then, holding the orders in memory, they would go to various parts of the warehouse to fetch the items. The assemblers had to remember the names as well as the quantities of items being assembled. Scribner *et al.* found that the assemblers departed from the list order of dairy items, and regrouped them to match the spatial locations in the warehouse. The regrouping functioned adaptively for the workers, since ti reduced the distance they had to walk as they assembled orders.

Increased capacity alone does not sufficiently characterize what we usually think of as skilled performance. According to Bartlett (1958), human skill 'possesses the outstanding characteristic of rapid adaptation'. According to Singleton (1978), different actions in a skilled activity gain coherence from an underlying goal, and skill includes the ability to combine actions into organized, directed patterns. The model of skilled memory, therefore, might usefully be expanded to include organizations of information which are recalled in adaptive, goal-directed ways.

The regrouping of information in memory might occur more than once in the flow of activity, and in different patterns. In order to investigate this issue I conducted a two-phase observational study of waitresses in a mid-town Manhattan restaurant during the lunch-hour shift. The focus was not on the capacity of the waitresses's memories, but rather on how menu items were organized at different points in the overall activity of serving meals to customers.

PARTICIPANT OBSERVER PHASE

In the first phase of the study I worked as a waitress for 3 months. I learned about the job by doing it, and by informally observing and talking to other waitresses.

A description of waitressing and the setting in which it occurs is necessary in order to appreciate uses of memory which can be described as adaptive; and my time as a participant–observer provided this description.

JOB DESCRIPTION

Customer versus waitress-oriented job sequence

From a customer's perspective, waitressing has a basic sequence in which the waitress takes an order, obtains the items in the order, serves them, and collects payment. The order itself has its own sequence, in which, for example, a dessert is not served before a sandwich. From the point of view of the waitress, however, a customer-oriented sequence is not especially useful. She must meet explicit speed and accuracy requirements both to keep her job and to get good tips; and her flow of activity must adapt itself to meet those requirements.

Physical setting

In the restaurant used in this study, waitresses work at U-shaped counters which seat 12 or more people. Customers sit at the counter, singly or in groups, as space becomes available. At any one moment, 12 customers may be at different stages of eating their lunch; some may have just ordered, some may be sitting down, some may be finishing up. The counters are at varying distances from the kitchen, which is divided into a hot and a cold section. At any one moment, food items which have been ordered by the waitress from one or both sections of the kitchen may be at different stages of preparation; and preparation time can vary depending on the food item itself or the business of the kitchen. The kitchen prepares the orders and puts them on a shelf, and the waitress picks them up and serves them. The waitress also picks up beverages and desserts from other locations and serves them. Soda machines are near the kitchens, and coffee and tea are at the counters. Dessert cases are between the kitchens and the counters.

Serving customers at different stages in the sequence

As some customers are being served, others are being seated; and the waitresses go to the new customers and take their orders. Except for groups of people seated together, most of the customers at a counter are at different stages of eating their lunch. As a matter of procedure in this restaurant, waitresses write checks as they take orders. Instead of carrying the checks with them, they leave them on the counter in front of the customers. Then, relying on their memories, they go to call items to the kitchen and to pick up other items. Since waitresses serve not one, but 12 customers, it is useful to save trips by ordering and picking up more than one item at a time. Speed requires coordination of actions, and therefore a regrouping of order items in memory which will make this coordination possible.

Restaurant memory versus laboratory memory

Unlike laboratory-administered materials, presented in uninterrupted linear sequence at controlled rates of speed, the to-be-recalled items for the waitress consist of frequently interrupted customer orders given at varying rates of speed, and often prompted by the waitress with such questions as 'And what would you like to drink?'. In the laboratory, recall is often at the subject's pace, and is also linear and uninterrupted. Waitresses' recall on the job, however, is both interrupted and non-linear. For example, a waitress may take several orders and start off to the kitchen to call them, but pause on the way to serve a beverage. While the kitchen is preparing items she cannot simply stand and wait for them. To satisfy the speed requirements of her job she must either pick up and serve other items, or else return to her counter and take other orders. At the same time she must monitor the kitchen area to see when sandwiches and entrées are ready. If someone waits too long for a sandwich, or if a hot item gets cold, tips will be reduced. When the items have been prepared by the kitchen, she loops back to pick them up, serves them, and proceeds to handle other items. Her recall occurs in series of loops as she travels back and forth between the counter and other locations. One set of to-be-remembered items is often interspersed with other sets of items, and speed is always a necessity.

When the waitress leaves her counter, relying on memory alone, to call or pick up a set of items, this provides a point of similarity to laboratory recall tasks. Points of difference, however, are more numerous. The input of the to-be-remembered items provides some additional differences. As the waitress takes orders from customers, instead of merely listening, she writes them down (usually in abbreviated form) on customer checks; and she often repeats orders back to the customers. The written checks are available on the counter as reminders, should she wish to use them. In trips to and from the counter, things like empty sandwich plates may serve as reminders of desserts. As a waitress approaches a counter, a customer may provide information about whose order she is carrying (in case she has forgotten) by such actions as clearing a space on the counter, or otherwise signalling the waitress. Therefore, there is always the possibility of some items being re-inputted with trips back to the counter from other locations, and the waitresses have to be alert to this information.

The number of items recalled provides a final contrast between waitressing and the laboratory. In a situation where the number of items recalled counts as data, full recall is seldom expected. Waitresses, however, one way or another, must serve to every customer all the items which they have ordered. This job description shows that serving a given number of correct orders is only one part of the way in which skilled waitresses use their memories. For a more complete picture we must follow over time what goes on both at the counter and away from the counter, in the overall flow of the waitresses' activity. This is what was done in the second phase of the study.

TRACKING THE ORDERS

Participating waitresses and customers

In this second, more systematic set of observations, three experienced waitresses agreed to participate. They had worked at this restaurant 14, 7, and 3 years respectively; and the manager described them as skilled. This meant that they could handle large numbers of customers at peak hours with a minimum number of mistakes. This study did not look at the effects of age on memory, so information about the waitresses' age was not collected; waitresses were chosen for their skill and familiarity with the restaurant.

A team of five confederate customers came to the restaurant after the busiest part of the lunch hour had subsided. They were introduced to the participating waitress, who knew they were part of the study, and seated together at her counter.

Audiotaping the orders

Each waitress agreed to wear a wireless microphone, so whatever she said while away from the counter could be recorded. The confederate customers wore lapel microphones. Each confederate ordered a lunch consisting of a sandwich, a dessert, and a beverage. Customer checks had been collected from two counters over a 2-day period, and it was found that the majority of orders were written in the form of sandwich, followed by desert, followed by beverage. This, therefore, was the sequence followed by the confederate customers as they gave their orders. Each confederate noted into his or her microphone when his or her sandwich, dessert, or beverage was picked up and served. Mistakes made by the waitress were also noted.

Information to be recalled

Five orders of three items each formed a recall list of 15 items. Hot and cold items were alternated in order to see if they would be reorganized, and if so, how. So each set of 15 items included three hot and two cold sandwiches (alternating), five desserts, and three cold and two hot beverages; arranged in clusters of three according to customer.

Observed sequence of activity

The sequence of activity observed in this study was that of a waitress handling orders for five people. It included taking the orders, calling them to the kitchen, and picking up and serving sandwiches, desserts and beverages. Four observations were taken on separate days for each of the three waitresses. In each observation the input from the waitress's wireless microphone, as well as from the lapel microphones of the customers, was recorded, via a mixer, onto one tape. The tapes from these observations were transcribed and analysed, and the written checks were also collected and analysed.

RESULTS

First I will report data on the waitresses' accuracy, followed by some interesting features of the written checks, then I will report the way in which order items were organized at different points in the sequence of activity.

Accuracy

Table 1, which includes the number of errors made by each waitress, shows an extremely high rate of accuracy. There are three possible types of error. First, a

Table 1. Number of errors

Waitress	Items forgotten	Items incorrect	Items served to wrong person
1	0	2[a]	3
2	0	1[b]	0
3	0	3[c]	0
Total	0	6	3

[a] Put unwanted whipped cream on dessert. Picked up extra dessert.
[b] Wrong bread for sandwich.
[c] Wrong bread for sandwich. No lemon with Tab. Unwanted whipped cream with dessert.

waitress could entirely forget to serve an item. This did not occur at all for any waitress. Second, an item could be handled incorrectly; for example, a sandwich could be served on the wrong kind of bread. Of the 180 items handled by all three waitresses in all 12 observations, this kind of error occurred three times. Third, an item could be served to the wrong customer. This occurred three times, and one waitress accounted for all three occurrences. The errors involved beverages and a dessert; in no instance did a waitress serve a sandwich to the wrong customer. In spite of the speed constraints of their job, these waitresses were very accurate.

In the interest of speed, when waitresses write down orders on customer checks, they write them in abbreviated form. None of the 60 checks I collected contained the name of any sandwich or dessert written out in full. Beverages such as tea or Tab were sometimes written out, but coke and coffee were not. Each waitress handled three orders for coffee, and in every case it was abbreviated with a C. The waitresses received between two and four orders for coke, and in every case it was abbreviated with a K. Of the 60 abbreviated sandwiches, 29 reflected the use of a standardized code used by the waitresses when calling orders to the kitchen. Examples of this code include 'Jack' for a grilled cheese sandwich, 'Combo' for a ham and cheese sandwich, and 'Egg' for an egg salad sandwich. Not all menu items are included in this code, but for those which are, the code shortens the time it takes to call the item, and helps to prevent time-consuming misunderstandings by the kitchen. So, these written checks reveal that at the same time the orders were taken by the waitresses, they were not only written down, but they were abbreviated and sometimes encoded in ways which would save time and minimize mistakes.

Organization of information in recall

Table 2 shows data from one of the waitress's transcripts which is typical of all 12 observations. To the left in Table 2 are the items as they were ordered by the customers. To the right, the items are listed in the sequence in which the waitress acted on the items. Calling the items to the kitchen was recorded on the waitress's wireless microphone, and was the first action on the sandwiches. Picking up and serving beverages, sandwiches, and desserts was recorded via the confederate customers' lapel microphones. The second appearance of sandwiches in the sequence to the right in Table 2 shows where they were picked up and served. These data reveal that although all of the orders were given in the sequence sandwich, dessert, beverage, there was not one case of a beverage being the last item handled. In five out of 12 observations, beverages were handled either before or after calling items

Table 2. Changes of sequence for menu items

Taking the orders	Obtaining the items	
Cheeseburger	Tea	Pick up and serve
Fruit salad	Coffee	Pick up and serve
Tab	Burger	Call to kitchen
	Cheeseburger	Call to kitchen
Egg salad	Grilled cheese	Call to kitchen
Jello	Egg salad	Call to kitchen
Tea	Chopped liver	Call to kitchen
	Tab	Pick up and serve
Grilled cheese	Sprite	Pick up and serve
Apple cake	Coke	Pick up and serve
Sprite		
	Cheeseburger	Pick up and serve
Chopped liver	Chopped liver	Pick up and serve
Rice pudding	Egg salad	Pick up and serve
Coffee	Burger	Pick up and serve
	Grilled cheese	Pick up and serve
Burger		
Chocolate pudding	Apple cake	Pick up and serve
Coke	Fruit salad	Pick up and serve
	Jello	Pick up and serve
	Chocolate pudding	Pick up and serve
	Rice pudding	Pick up and serve

to the kitchen. In the remaining observations, beverages were handled either right after calling items to the kitchen, or else interspersed with serving sandwiches. In addition, in all 12 observations, when sandwiches were called to the kitchen, they were sorted according to whether they were hot or cold. Therefore not only were sandwiches and beverages pulled form a list of 15 items and handled together or first, but different kinds of sandwiches and beverages were clustered together. Desserts were also clustered, and although they were always the second items ordered, they were always the last items served.

Bousfield and Bousfield's (1966) relative ratio of repetition, which measures the amount of clustering in free recall of members of non-overlapping categories, was used to analyse the waitresses' sequences of action. Lists were compiled of the first action with each item after taking the order; that is, calling sandwiches to the kitchen, and picking up and serving beverages and desserts. Sandwich pick-up, which depended on kitchen preparation time, and which was the second action with the sandwiches, is not included in this next analysis. Table 3 shows a retrieval sequence with three possible sets of categories to which each item could belong.

The relative ratio of repetition

The relative ratio of repetition (RRR) is obtained by comparing the number of stimulus category repetitions which occur in recall with the number which may be expected to occur by chance. So if 'sandwiches' is a category, and a waitress handles five sandwiches in a row, this would be four stimulus category repetitions, or SCRs. The observed SCRs form the numerator, and the expected SCRs, form the denomina-

Table 3. Possible category membership of retrieved items

Order sequence	Retrieval	Retrieval and possible categories 1[a]	2[b]	3[c]
Grilled cheese	Chopped liver	4	1	Cold kitchen
Cheesecake	Turkey	2	1	Cold kitchen
Birch beer	Cheeseburger	5	1	Hot kitchen
Turkey	Grilled cheese	1	1	Hot kitchen
Fruit salad	Grilled cheese with bacon	3	1	Hot kitchen
Tea	Sprite	5	3	Cold machine
Grilled cheese with bacon	Birch beer	1	3	Cold machine
Jello	Tab	3	3	Cold machine
Tab	Tea	2	3	Counter
Chopped liver	Coffee	4	3	Counter
Chocolate pudding	Cheescake	1	2	Cake/pie case
Coffee	Jello	3	2	Kitchen area
Cheeseburger	Fruit salad	2	2	Kitchen area
Rice pudding	Chocolate pudding	4	2	Kitchen area
Sprite	Rice pudding	5	2	Kitchen area

[a] Customer = no. 1, 2, 3, 4, or 5 in order sequence.
[b] Food types: sandwich = 1, dessert = 2, beverage = 3.
[c] Restaurant location.

tor in obtaining the relative ratio of repetition. The following example will illustrate the computation of the expected SCRs.

If we want to determine the number of times a waitress would deal with items for the same customer one after the other (if she were grouping items by customer), we must remember that there are five customers who each ordered three items. So for each of five customers, the waitress has three opportunities to begin a stimulus category repetition, or SCR. Using the formula $E = (m(m-1))/15$, where m stands for these opportunities and 15 is the total possible number of customer–item pairings, E for each customer comes to .40. In other words, if a customer in this situation orders three items there would be a 40 per cent chance that two items in a row would be handled by the waitress if chance alone were operating. Since there were five confederate customers, the expected number of SCRs for the entire observation was two.

Three sets of categories, or organizational schemes, were used to look at clustering. One retrieval scheme might be organization by customer. Since Bennett's (1983) and Ericsson and Polson's (1984) subjects used versions of the method of loci in obtaining and serving customer orders, it seemed reasonable to suppose that customers as categories might be reflected in the retrieval sequence. Another organizational scheme might be food categories, since the checks were written in the sequence sandwich, dessert, beverage. A third possibility, since sandwiches were sorted into hot and cold, might be locational categories in the restaurant. Table 4 shows the observed SCRs and RRRs for these organizational schemes.

When 'customer' was used as an organizing principle, the mean RRR was .17, which means that the observed SCRs were .17 of what one would expect to occur by chance. In nine out of 12 observations there was not one observed SCR. The waitresses' retrieval sequences did not reflect the use of customers as organizing

Table 4. Observed SCRs and RRs for three possible item categories, by waitress and observation

	Item categories					
Obs.[a]	Customers (5) SCRs/RRR		Meal items (3) SCRs/RRR		Locations (6) SCRs/RRR	
1.1	1	.50	10	2.50	8	4.28
1.2	0	0	11	2.75	8	4.28
1.3	0	0	11	2.75	9	4.80
1.4	0	0	12	3.00	9	4.80
2.1	0	0	12	3.00	8	4.62
2.2	0	0	12	3.00	7	4.38
2.3	0	0	12	3.00	9	4.80
2.4	0	0	12	3.00	7	4.38
3.1	1	.50	10	2.50	5	3.13
3.2	0	0	12	3.00	9	4.80
3.3	2	1.00	12	3.00	8	3.76
3.4	0	0	12	3.00	8	4.28
Mean RRRs:		.17		2.91		4.36

Note: The number of expected SCRs within one set of five orders was 2.00 for customers, 4.00 for meal items, and 1.60 to 1.87 for locations (depending on the meal items for that set of orders).
[a] Waitresses 1, 2, and 3 each were observed four times.

categories. This is interesting, since all of the items were eventually served to the people who ordered them, and I will return to this point later. In contrast, the mean RRR for type of food item was 2.91; almost three times what one would expect by chance. Finally, if we look at retrieval sequences as organized by restaurant location, we see that the mean RRR is 4.36, the highest clustering score of the three alternatives tested. This reflects the fact that, after the waitresses took the orders, sandwiches were not only pulled out and handled together, but were sorted into hot and cold. The waitresses appeared to be using a double classification system; type of item, subclassified by location, such as hot or cold kitchen. Beverages were clustered according to whether they were obtained at the counter or the cold soda machine. Desserts were clustered according to whether they came from a dessert case near the kitchen, or a separate cake and pie case near the counters.

DISCUSSION

Memory as linkage between person and context

Researchers such as Chi and Koeske (1983) and Rabinowitz and Mandler (1983) have used Bousfield and Bousfield's measures of clustering as evidence of links between items in either a semantic network or a schematic or taxonomic organization of information inside the head of the rememberer. 'More and better-structured knowledge', say Chi and Koeske, is necessary for improved memory performance. By better-structured, they meant more links between items in a semantic network. Such links, they hypothesized, are formed by repeated exposure. This characterization of an internal knowledge structure resembles the well-learned body of information on running times which Chase and Ericsson's (1981) subject used to encode digits.

In both cases the emphasis is on organization inside the head. The waitresses in this study, however, are organizing information in a restaurant which has its own organization. At the same time they are dealing with constantly changing configurations of customers. This in turn means constantly changing configurations of order items at the counter, at the soda machine, at the dessert cases, at the hot kitchen, and at the cold kitchen. This study suggests that clustering can also be interpreted as evidence for links between the person and the context in which she is working, in the form of adaptive organizations of information.

Changing task demands and changing organization

If this is so, why would customers as categories not be reflected as clustering in the retrieval sequences? In order to answer this I will briefly review what the waitresses are doing. There are really three tasks which memory must perform if customers are to be served quickly and accurately. First, the correct order items must be obtained. This includes calling items to the kitchen and picking up and serving sandwiches, desserts and beverages. The second task is to monitor the kitchen so that items can be picked up when they are ready. In the interest of speed it is important to monitor the kitchen in such a way that attention can be allocated to other activities, such as serving beverages. Perhaps this resembles the 'strategic time monitoring' Ceci and Bronfenbrenner (1985) talk about in their study of prospective memory. The third task for memory is to enable the correct items to be served to the customers who ordered them. The configurations of information held in memory for each of these tasks may be different. In this study, order items were given to the waitress in one sequence, organized by customer. This organization was not reflected in calling items to the kitchen, or in picking up and serving desserts and beverages. Instead, items were clustered according to locational categories. Customers as categories were not relevant to the task at hand at this stage of handling orders. The restaurant locations, however, were not relevant when it came to serving the orders. The fact that only three out of 180 items were served to the wrong customers suggests that an organization of information in which meal items were associated with customers was called on by memory for this task. Perhaps the information was organized in different ways and was multiply encoded by the waitresses who, being skilled at their job, anticipated different uses for the information at different points in their flow of activity.

Combining activities and maintaining information

According to Singleton (1978), different actions in a skilled activity gain coherence form their underlying goal. The goal provides the activity with both meaning and direction; so the ability to combine actions into organized, directed patterns is a characteristic of skill, and, says Singleton, 'One thing for a skilled man may be half a dozen things for an unskilled man.' The waitresses in this study clearly demonstrate this feature of skilled activity. For example, as the waitresses wrote customer checks they were simultaneously taking orders and anticipating future payment. Their abbreviations also reflect the job's speed and accuracy requirements. The data in this study suggest that the waitresses may have been sorting items by location as they wrote them down by customer. Ten out of the 12 observations in this study revealed that the waitresses, after calling orders to the kitchen, immediately picked up drinks from the soda machine near the cold kitchen. They did this without any re-inputting of information from returns to the counter. So, whatever form of encoding the waitresses used, it not only allowed for different configurations of items, but it also included a change in sequence. The sandwich–dessert–beverage sequence of the original orders became sandwiches followed by beverages or, in some cases, beverages followed by sandwiches, with desserts being the last items handled.

Information was apparently not being cleared out, as from a short-term buffer, but maintained for future use.

Changing limits of current activity

Whether the waitresses selectively move back and forth between different forms of encoding, or whether they differentially access parts of a larger internal representation of their activity, in which individual items may appear more than once, cannot be resolved by this observational study. Nevertheless, the data present a picture of the organization and retrieval of information within a fluid and dynamic system. The system includes not only the waitress and what is inside her head, but changing as well as stable features of the context in which she is working. The data also raise the question of how short is short term storage. William James (1890/1950) used the term 'primary memory' to refer to 'the trailing edge of the conscious present'. Primary memory, according to James, allows us to keep track of current experience, while long-term memory allows us to make use of past experience. Singleton (1978) has used the terms 'running memory' or 'dynamic memory' to refer to memory functioning in the context of current activity. Chase and Ericsson (1982) say 'We simply assume that short term memory is the set of knowledge structures that are currently active.' For Chase and Ericsson, short-term memory holds information which is about to be inputted to a control process. Current activity, then, seems to refer to an unspecified number of seconds, rather than minutes or hours. Remember that Chase and Ericsson used the term 'Skilled memory' rather than working memory in order to avoid the notion of limited capacity. However, in their formulation, skilled memory includes a short-term component, limited both with respect to capacity and time, which holds information either from the external environment or from long-term memory, which is about to be inputted to a control process.

The data from this study suggest that the limits of current activity, with respect to both time and capacity, may change depending on the nature of the activity. From the time a waitress takes an order until she serves the dessert and collects payment, her memory is accessing a set of informational items in different ways at different times in the flow of activity. Let us examine a small chunk of time within this flow. For example, taking a set of five orders, walking from the counter to the kitchen to call them, picking up beverages on the way back and serving them, takes more than a few seconds. For the waitress this chunk of activity is all of a piece. At the same time there are seven other customers at that counter, and there are other chunks of activity associated with them. It would be more meaningful, from a waitress's perspective, to think of current activity as patterns of informational sequences, adaptively organized, which makes it possible for her to do her job; rather than time intervals of several seconds. If we think of current activity in this way, then we must broaden our view of the role of temporary storage in information processing. Skilled memory therefore, if we look at its use in real-world tasks, besides providing links between short- and long-term memory to allow for increased capacity and rapid access, can also be thought of as providing adaptive organizations of information; and therefore links between what is inside and what is outside of the head.

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