ATTENTION AS A LIMITED CAPACITY RESOURCES
1. Preparation for and performance of motor skills are influenced by our limited capacity to select and attend to information.

2. Study of attention explains how we can perform more than one voluntary skill at the same time.
ATTENTION

It has been proven for many years that we have attention limits that influence performance when we do more than one activity at the same time.

Attention is directly related to our ability to detect relevant information in the performance environment.
THEORIES OF ATTENTION

- Filter or bottleneck theory
- Central-resource capacity theory
- Multiple Resource Theory
Reason why people have problems performing two or more tasks at the same time is because the human information processing system performs each task in serial order. Somewhere in the system (see above diagram) there exist a bottleneck where it filters out information not selected for further processing.
At what stages does this bottleneck occur?

<table>
<thead>
<tr>
<th>Stage</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welford contends if we want one to attend we need to make the client or learner more aware of sensory information that occurs during detection of environmental information.</td>
<td>Sensory orientation is necessary when learning and performing. E.g., we inform the performer about visual, auditory, and proprioceptive cues in the performance environment.</td>
</tr>
<tr>
<td>Norman contends if we want one to attend we need to make the activity more meaningful or important that is occurs after information was perceived or processed cognitively.</td>
<td>Making the cues in the environment standout and meaningful helps the performer process information. E.g., watch the ball all the way into the glove in catching.</td>
</tr>
</tbody>
</table>
Theoretical Viewpoint

- Many researchers content that people carry out information processing in parallel rather than serially.
- Attention limits are a result of the limited availability of resources needed to carry out various functions.
- Basic premise is we can perform several tasks at the same time, as long as the resource capacity limits of the system are not exceeded.
Where the resource limits exist?

<table>
<thead>
<tr>
<th>Central resource capacity view</th>
<th>Multiple resource capacity view</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is one resource pool from which all attention resources are allocated.</td>
<td>There is multiple sources of resources from which all attention resources are allocated</td>
</tr>
</tbody>
</table>
Central-Resource Capacity Theory

- Single resource pool from which all attention activities must be funded.
- If tasks A & B resources do not take up all the resources of pool (larger circle) both skills can be performed successfully simultaneously!
Kahneman’s Attention Model

Kahneman equates attention with “cognitive effort” and proposed a flexible capacity limits which vary depending on the environment, task being performed, and individual’s conditions (e.g., level of arousal, expert vs non-expert).
Success in performing two or more tasks at the same time

- Depends upon:
  - Amount of attention resources available varies in relation to a person’s arousal level.
    - Maximum amount available only when arousal level is optimal for the situation.
  - How we allocate our attention resources.
    - Depends on the 3 “rules” people use to allocate attention resources
3 “rules” people use to allocate attention resources when performing multiple tasks

1. Ensure completion of at least one task
2. Enduring disposition: involuntary attention allocation, e.g.,
   a. novel for the situation
   b. meaningfulness of the event
3. Momentary intentions
   a. allocate resources according to instructions.
Multiple Resource Theory

- We have several attention mechanisms, each having limited resources.
- The multiple sources are based on specific information processing components:
  - Sensory input (e.g., proprioceptive, vision)
  - Response output (e.g., verbal, motor)
  - Type of memory code (e.g., verbal, spatial)
- Performance of simultaneous multiple tasks depends on competition for attention resources within and between multiple sources:
  - Two tasks share or compete for common resources which exceed the sources, performing multiple tasks at the same time is difficult.
Multiple-Resource Theory

- We have three task above which needs certain resources in order for the task to be successfully performed.
  
  - Task A
    - Vision = 75%
    - Memory = 15%
    - Timing = 10%
  
  - Task B
    - Vision = 35%
    - Memory = 75%
    - Timing = 95%
  
  - Task C
    - Motor = 75%
    - Verbal = 25%

- Two of the above task can be performed simultaneously and two cannot.

- What are they?
Success in Performing two or more tasks at the same time

- Depends upon.....
  - If the task demands out attention from a common resource or different resources.
    - If two or more task are similar they will draw on a common resource pool this will affect our performance negatively.
    - If the two or more skill require different resources then performing both at the same time can occur with little effects.
Cell Phone Use and Attention

Laws seek to end teen drivers’ cell calls, texting

BY RACHEL KONRAD
ASSOCIATED PRESS

SAN FRANCISCO — Narin Leininger knows about the risks of talking on a cell phone or sending text messages while driving. The 16-year-old high school junior says he’d only use his phone behind the wheel in an emergency — a flat tire, traffic jam or crash.

But if he ever decided to whip out his phone to chat or text with a friend while steering, he wondered, could anyone stop him?

“There’s no way a cop could see if you’re texting under the steering wheel,” said Leininger, a student at San Francisco’s Lowell High School.

Still, California and more than a dozen other states are considering bills banning teens from using electronic equipment while driving.
Attention & Cell Phones while Driving

- Half of the motor vehicle accidents in U.S. can be related to cell phone use.

- Using the three theories explained above, why is driving influenced by cell phone usage?
  - Filter theory explanation (filter)
  - Central capacity theory explanation (allocation)
  - Multiple resources theory explanation (same or different resources)
PROCEDURES FOR ASSESSING ATTENTION DEMAND

- Determines the attentional demand of that activity by noting the degree of interference caused on one task being simultaneously performed with another task.
- Dual Task Procedures (Tuesday’s Lab)
  - Probe technique
  - Continuous task technique
In Amsterdam, the tile under Schiphol’s urinals would pass inspection in an operating room. But nobody notices. What everybody does notice is that each urinal has a fly in it.

Look harder, and the fly turns into the black outline of a fly, etched into the porcelain. It improves the aim. If a man sees a fly, he aims at it. Fly-in-urinal research found that etchings reduce spillage by 90%. It gives a guy something to think about. That’s the perfect example of process control.

In the men’s bathroom, why do you think they place a fly under the tile of the urinals???
FOCUSING ATTENTION

Attention Focus

- The directing of attention to specific aspects of our performance or performance environments
  - Width of focus
    - Focus can be broad or narrow
  - Direction of focus
    - Focus can be internal or external

- Attention switching
  - The changing of attentional focus characteristics in a performance situation
FOCUSING ATTENTION IS A MANAGEMENT PROBLEM

- When we perform we need to maintain a flexible (attention switching) attentional focus in both width and direction.

- Stress causes most of the attention problems
Should I focus on my movements or on the effects of one’s own movements?

- Internal versus External Question
  - Internal focus is one that is directed at the performer’s own body movements. (e.g. pushing on the pedal while cycling)
  - External focus is directed at his or her movement have on the environment. (e.g. cycling while measuring one rpms)

- Action effect hypothesis (Prinz, 1997)
  - Wulf’s (2007) Review & Abstract Assignment
ATTENTION AND AUTOMATICITY

- Automaticity = performance of a skill (or parts of a skill) without requiring attention
- Automaticity is acquired through practice (Logan)
- Neural components associated with automaticity of motor skill performance
  - Poldrack (2005) fMRI research that showed different brain areas are activity when performing tasks that require differing task demands.
Visual Selective Attention

- The 2\textsuperscript{nd} aspect of study of attention as it relates to motor skill performance.
  - The use of vision in the selection of environmental information in the preparation and/or performance of a skill.
  - \textit{Visual search} is the process of directing visual attention to locate relevant information (i.e., cues) in the environment.
    - \textit{Flicker task activity: What has changed!}
Visual Selective Attention

Do we actively seek out relevant environmental information or do we just attend to environmental cues because of their distinctiveness or meaningfulness?

- Visual attention is both an active and passive process (Egeth & Yantis, 1997)
- Visual awareness activity: selective attention
  - Count the number of passes by the white shirts
Visual Selective Attention

- Eye-movement recordings
  - Commonly used technique to investigate visual selective attention
  - What a person is visually attending to inferred from “point of gaze” (i.e., locus of central vision)

- What is the relationship between eye movements and visual selective attention?
  - Does what person is “looking at” (i.e., point of gaze) indicate where visual selective attention is directed?
HOW TO SELECT VISUAL CUES?

- Performer *actively looks* for specific cues that will enable him or her to achieve a specific skill or action.
  - How the pitcher is standing.
  - If the pitcher front foot is going home or to first base.
  - Speed of the pitcher’s move.

- Performer *actively* searches the environment according to specific intended actions.
  - First base coach say, “watch the pitchers shoulder opposite their throwing hand for any cues if he is going home or to first base.”
Why do we pick one cue over another?

- During visual search…
  - We first initially group stimuli together according to their unique features (e.g., shape of a pig or boot)
  - These features form maps
  - Once maps are formed we attempt to identify specific cues based on the demands of task or cues of interest (pop out)

- Feature Integration Theory
Find the pig and boot in this picture
What makes certain features or cues more distinctive than others?

- Cues or feature of movement that are unexpected
- Meaningfulness
- Novelty
Visual Search & Action Preparation

- Visual search picks up cues that influences 3 aspects of action preparation
  - Action selection
  - Constraining of the selection action (i.e., specific movement features for performing the action)
  - Timing of the action initiation.

- Note how these three preparation processes influenced by visual search in:
  - Open motor skills
  - Close motor skills
## VISUAL SEARCHING RELATED TO OPEN MOTOR SKILLS

| **BADMINTON** *(Abernethy & Russell)* | Experts have more time to prepare their returns (83ms) than non-experts | Racquet and the arm are the primary sources to visual search for anticipatory cues need to return. |
| **BASEBALL HITTING** *(Shank & Haywood)* | Experts can identify every pitch correctly | Experts fixated on release point of pitcher starting in the delivery to the release point |
Return of Tennis Serve

Experts were different in their visual searching strategy as compared to novice players (Goulet, Bard, & Fleury, 1989).
### VISUAL SEARCHING RELATED TO OPEN MOTOR SKILLS

<table>
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<tr>
<th><strong>Soccer (Williams, et al)</strong></th>
<th><strong>Driving a car (Mourant &amp; Rockwell)</strong></th>
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<td>Experts take less time in determining to shoot versus dribble; takes fewer eye fixations; fixated on players hips; used peripheral vision to select relevant cues.</td>
<td>Expert drivers look more immediately in front of the car and to the left; fixation are shorter but search a wider area; look in rear view mirror more often; require less time to process visual information in dangerous driving conditions.</td>
</tr>
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- **Soccer (Williams, et al)**: Experts fixated more on the positions and movement of others where as novice tracked the ball.
- **Driving a car (Mourant & Rockwell)**: Experienced drivers eyes fixations were different for expert versus novice; expert’s eyes jump from location to location where as inexperienced drives make pursuit eye movements.
## VISUAL SEARCHING RELATED TO OPEN MOTOR SKILLS

<table>
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<tr>
<th>Baseball &amp; Softball Umpires (Millslagle, Smith, &amp; Hines)</th>
<th>Experts fixated at the pitcher release area sooner in the deliver and for a longer time; tracked the ball in flight longer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts had more efficient visual motor control than non experts</td>
<td></td>
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### Locomoting

1) Eyes must be fixed on the object to make contact
2) To avoid one must know the relative location or motion of the object

<table>
<thead>
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<th>Eyes determined the location and distance of the object in making contact</th>
<th>Person needs to fixate on the object if he/she wishes to avoid the object.</th>
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VISUAL SEARCHING RELATED TO CLOSED MOTOR SKILLS

<table>
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<tr>
<th><strong>Shooting A free throw</strong> <em>(Vickers)</em></th>
<th><strong>Putting a golf ball</strong> <em>(Vickers)</em></th>
</tr>
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<tbody>
<tr>
<td>Experts look directly at the backboard or hoop longer</td>
<td>Experts have a longer preparation period, that is, time just after golf completed positioning the ball and just before initiation of the backswing</td>
</tr>
<tr>
<td>Non experts did not fixate long enough prior to the release</td>
<td>Fixation on the club led to more missed putts where as fixation on the ball led to more made putts. Keeping the head stable and moving the eyes is better than moving the head.</td>
</tr>
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</table>
The “Quiet Eye”

- Occurs for both open and closed skills
- Fixate their gaze on a specific location or object for a period of time before initiating performance

4 Common Characteristics
- Directed to a critical location or object
- It is stable fixation of performers gaze
- Its onset occurs before the first movement of the performance
- Its duration is longer for elite performers
Visual Search Training

- Generalized visual search training has been found to be not effective whereas performance situational visual training has been found to be effective.
  - Needs to have specific patterns or strategy that is related to the activity
  - Sport specific
  - Visual search success is based on experience in specific performance situations
- Effective rehab contexts to facilitate performance of skills requiring visual search remains to be determined.
Visual Searching Training

- Provide sufficient practice in the environment where the skill will be performed.
- Make sure the “key environmental cues” are present when practicing in the real environment.
- Success often results from learning relevant visual cues without conscious awareness of them (i.e., implicit training)