Introduction to Handout
Sources: [1]Damasio, 1999. [2]McConnell, 2012 [3]LeBlanc, 2009. [4]LeBlanc, 2019. [5]Feltovich, 2006.

This handout accompanies the simulation workshop Cognition: Engagement to Expertise. Simulation is commonly chosen to improve decision-making and teamwork. Facilitators work hard to learn how to foster engagement. Both simulation and faculty development are expensive, and we offer the workshop and handout to explain why the effort is justified given these learning goals.

We focus on engagement in simulations focused on decision-making or teamwork: what it is, why it matters, and how do we get it. We suggest:

- Engagement in a simulation is a process using emotion and reflection to ascribe meaning to the simulation for other situations.
- Experts recognize situations and identify likely responses much too fast for conscious thought; engagement matters because it trains these expert responses.
- Facilitators promote engagement by working with participants to derive a story about their simulation experience that is useful for the future.

Both the workshop and the handout start with why engagement matters in order to identify the goal.

Workshop Design:
The proposal above draws on diverse sources that take time to integrate. However, it suggests that engagement is a tool to develop meaning. Thus, if participants engage with famous psychology experiments, we hope they will reflect on the analogies between the results and their experience with simulation. The handout provides detail and literature support.

Application:
The workshop changes little of the practice of simulation for experienced practitioners; it articulates reasons for what we already do. We write learning objectives that go beyond declarative knowledge because simulation can be a tool to develop expert decision-making. We do thorough prebriefing and respectful debriefing because the story the participant creates about the global experience affects the change in skills and attitudes. Our simulation may start with participants imitating routine aspects of their job so their own actions reinforce their story of the simulation as metaphor for reality.

Terms:

Emotions are neurophysiological events, while feelings are the corresponding subjective experiences.[1] Their evolutionary role is to support and accelerate making and implementing decisions.[1] Intensity of emotion is only one of many factors involved in its impact on learning.[2-4]

Engagement in a simulation is a process using emotion and reflection to ascribe meaning to the simulation for other situations. (Definition proposed here)

Expertise is a set of capabilities within a specific domain that cannot be transferred quickly from one person to another but only learned with deliberate practice.[5] An example in a crisis might be to use a calm tone and a closed communication loop to delegate a task rather than personally doing the task.

Part I: Why Engagement Matters

Overall: There is experimental evidence that expertise involves automated associations that operate much faster than conscious thought, and that decision-making in the face of uncertainty is substantially emotional. Highly trained "gut-level" instincts are vital to expert decision-making.

General Notes on Expertise: Expertise is a set of capabilities in a specific domain that cannot be transferred quickly from one person to another but only learned with deliberate practice.

System I Daily-Life Expertise: We are experts in many of our daily functions in life, using System I (non-conscious processing) programs from either evolution or experience.

System I Professional Expertise: Many of the superior capabilities of experts are in System I (non-conscious processing) that has been programmed by experience.

Iowa Gambling Task: Decisions under conditions of uncertainty, including decisions that we consider primarily rational, are generally driven by emotion.

Implications of Brain Lesions on Knowledge, Skills, and Attitudes: Emotions evolved to facilitate decision-making in an uncertain world.

General Notes on Expertise
Sources: [1]Feltovich, 2006. [2]Cianciolo, 2006. [3]Gobet, 2006. [4]Dror, YouTube.

Moral of the Story: Expertise is a set of capabilities in a specific domain that cannot be transferred quickly from one person to another but only learned with deliberate practice.

Proposed Implication for Simulation: Experts think in ways that are qualitatively, not just quantitatively, different from novices. Simulation promotes a type of learning that is qualitatively, not just quantitatively, different from didactic methods.

Expertise is a diverse set of capabilities sometimes including trade-offs.[1-4] Obviously, for example, expertise in many domains requires psychomotor skills. In this workshop, we are particularly concerned with attitudes and cognitive skills that promote effective decision-making and interactions with teammates that operate much too quickly for conscious analysis.

Formal study of expertise tells us that the qualitative differences in thought between experts and novices cannot be readily transferred from one person to another.[1-3] These expert thought patterns can only be acquired by experience with feedback (the feedback may come from the environment). This supports the suggestion that something other than conscious analysis is involved.

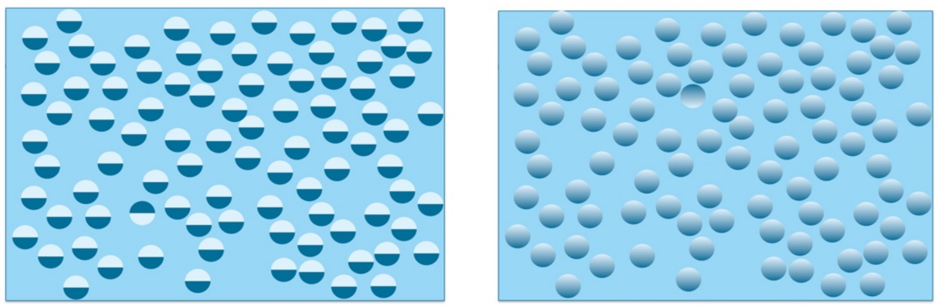
System I Daily-Life Expertise

Sources: [1]Kahneman, 2011. [2]Dror, 2011. [3]Dror, YouTube. [4]Damasio, 1999. [5]Gazzaniga, 2011.

Moral of the Story: We are experts in many of our daily functions in life, using System I (non-conscious processing) programs from either evolution or experience.

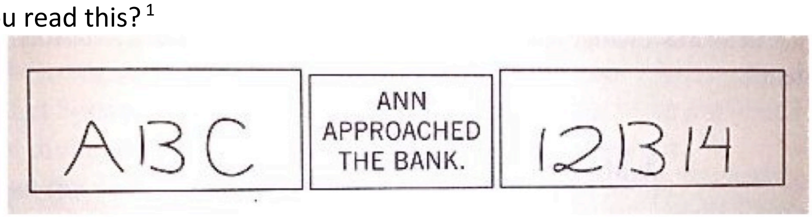
Proposed Implication for Simulation: Learning expertise from simulation may sometimes be less what we teach and more the automated programs we help participants develop: pattern recognition, situation awareness, communication skills, decision-making, psychomotor skills, etc.

Example 1: Pick the odd dot out. [2,3]



For most people, this demonstrates the amazing speed with which our non-conscious System 1 effortlessly solves the problem on the right. The first time I saw this example I thought it was unfair because it compared a two-dimensional problem to a three-dimensional problem. Wrong! They're both 2D problems. We are such experts at interpreting 3D structure from shading, we do it automatically.

Example 2: Can you read this? [1]



Most people see alphabetical characters on the left and numbers on the right. Ann is walking toward a big building with tellers inside. We are such experts at reading that System 1 has quickly interpreted for us without our awareness. The "B" and "13" are in fact identical characters. Someone who lived on a river might see Ann rowing a canoe.

Example 3: Snake! [4,5]

Emotion used to be considered just messy interference with rational reason. That view is inconsistent with evolution resulting in such influence of emotion on behavior. The evolutionary purpose of emotion seems to have been to bias us toward typically favorable decisions and prepare our physiology. We think we become aware of a snake and jump back, but we have the sympathetic response and signal to our motor nerves many milliseconds before our consciousness recognizes the snake.

Conclusion: Non-conscious processing is very fast, performing interpretation, filtering, and some decision-making without our effort or awareness. It can be trained to tie a shoe or drive a stick-shift.

System I Professional Expertise
Sources: [1]Klein, 2009. [2]Kahneman, 2011. [3]Gobet, 2006. [4]Kahneman, 2009.

Moral of the Story: Many of the superior capabilities of experts are in System I (non-conscious processing) that has been programmed by experience.

Proposed Implication for Simulation: The aspects of simulation relating to expertise may not always be what we teach the participants; we also help the participants develop automated programs: pattern recognition, situation awareness, communication skills, decision-making, psychomotor skills, etc.

Example 1: Gary Klein studied decision-making in firefighters and tells story after story of expertise: in many cases the subjects were not consciously aware of their thought process.[1] In one striking example, a leader suddenly ordered all his men to leave a house immediately.[2] Moments after they got out, the floor collapsed. Only after careful debriefing could he reconstruct the reason for his order. The room was much too quiet for the great heat on his ears, so the main fire was hidden below.

Example 2: Contrary to popular opinion, chess grandmasters do not see several more moves ahead than strong amateurs.[3] Rather, they abstract the chess-salient features of a position and likely candidate moves at a glance, much as the rest of us interpret a three-dimensional structure from shading (see Daily Life Expertise). Indeed, eye-tracking hardware shows they look at zones of a chess-salient arrangement rather than individual pieces. After five seconds, they can reconstruct an arrangement involving 25 pieces with perhaps 1 mistake. However, if they attempt the same with 25 randomly placed chess pieces, they will get approximately the same 4 or 5 right as most of us.

Example 3: Experienced neonatal ICU nurses were able to predict which infants would develop sepsis before the blood tests were positive, but were unable to accurately explain their predictions.[4] Researchers used semi-structured interviews, much like those with the firefighter, about a variety of specific instances to derive a set of cues and patterns, some of which were not yet in the literature.

Conclusion: One aspect of expertise is domain-specific System I associations from experience.

Extrapolating Further: All three examples could be described as pattern-recognition, but at a minimum the first two cases also associate likely actions. Training System I is where simulation shines relative to other learning methods. If everything in your learning objectives is handled in conscious processing, then you might consider one of two alternative hypotheses:

1. You have a secret learning objective, and it might be more exciting if you make it explicit.
2. You will spend much less time and money doing a problem-based learning discussion (or possibly even a web video and quiz) instead.

Iowa Gambling Task
Source: [1]Bechara, 1997. [2]Damasio, 1999. [3]Bechara, 2005.

Moral of the Story: Decisions under conditions of uncertainty, including decisions that we consider primarily rational, are generally driven by emotion.

Proposed Implication for Simulation: When we're training decision-making in uncertainty (probably much of expert decision-making) we're largely training emotional biases, not just conscious analysis.

Subjects were told to select cards one at a time from one of four decks with the goal of winning as much money as possible.[1-3] Each card selected yielded either a winning or a losing amount of money. They were not told that two of the decks involved larger amounts of money than the other two. In the long run, choosing the high-money decks tended to lose, choosing the other two decks favored winning.

Normal subjects soon bias their decisions toward the large-money decks, but have a sympathetic nervous system response to each loss. They gradually also develop a sympathetic response to their choice, before they know the result. This anticipatory response increasingly biases their choices toward the winning decks, first without their awareness but later they report a hunch. Finally, after about 80 choices, they correctly describe the behavior of the decks and bias their decisions slightly further.

Subjects with bilateral lesions in the ventromedial prefrontal cortex start like normal subjects, biasing initially toward the large-money decks and having a sympathetic response to each loss. However, they never develop the anticipatory sympathetic response, they never articulate the hunch, and they never develop a strong bias in favor of the lesser-money, winning decks. At about 80 choices they describe the decks as accurately as normal controls, but there is only a small improvement in their decisions.

Conclusion: While choosing the deck with the better odds seems to be a simple, rational choice, humans under conditions of uncertainty generally make such choices on the basis of a learned emotional bias.
See also: Implications of Brain Lesions.

Implications of Brain Lesions for Knowledge, Skills, and Attitudes
Source: [1]Damasio, 1999. [2]Bechara, 1994. [3]Liebermann, 2012. [4]Klein, 2009. [5]Kahneman, 2009. [6]Bechara, 2005.

Moral of the Story: Emotions evolved to facilitate decision-making in an uncertain world.

Proposed Implication for Simulation: Educators often break down learning into knowledge, skills, and attitudes, and most of us suspect attitudes have an emotional component. Many of us don't conclude that from a practical standpoint, an attitude that is useful in job performance is simply a favorable gut-level bias in decision-making.

The Iowa Gambling Task (IGT, see separate page) was developed because a patient (Elliot) was referred so his disability could be identified.[1,2] He had had a brain tumor removed from the ventromedial prefrontal cortex (vmPFC), but his previous success in finance, family, and society had evaporated. Yet he scored above the 95th percentile in tests of intelligence and memory. Elliot also tested well relative to his peers in hypothetical social dilemmas, describing options, likely consequences, and effective steps. Despite Elliot's repeated recent failures in life, no then-existing lab test identified a problem.

In retrospect, the tests of social dilemmas resembled problem-based learning discussions. In life, in the IGT, and in simulation, we do not enumerate options and likely outcomes, we make a decision in the face of uncertainty and learn from the consequences. Elliot and other patients with vmPFC lesions perform as poorly in the IGT as in life.

A brain lesion with opposite effects produces opposite results. Patients with severe lesions of the hippocampus cannot transfer short-term conscious memories into long term. Yet one was taught writing in a mirror after his accident: he always thought he couldn't do it, but he retained the skill when tested.[3] Another had repeated positive, negative, and neutral interactions with three different people. He never recognized any of them, but when asked who would be most likely to become his friend, he regularly picked the one with whom he had had positive interactions. [1] This was notable, as he was attracted to women, and an attractive young woman had been deliberately chosen for negative interactions. Skills and attitudes, it seems, may be largely separable from conscious memory.

Conclusion: We have always known emotions influence decisions. It seems they are largely the way we make decisions in uncertainty,[6] and certainly facilitate doing it quickly.

Extrapolating further: Research in naturalistic decision-making suggests that much laboratory research on decision-making in the 20th century did not reflect real-life.[4,5] The profound impairment in real-life without emotional processing, and the failure in the laboratory to detect that impairment prior to the IGT, suggest that many lab tests took inadequate account of uncertainty. Moreover, if attitudes are emotional biases, a useful attitude to train may be an instinct to communicate to a team leader in a closed loop instead of calling out information to the room. By contrast, a learning objective of a "team attitude" that everyone should focus on the common goal may be addressing a personality disorder that is uncommon in healthcare professionals.

Part II: What Is Engagement (step 1)

Overall: That expert decision-making requires, in part, highly trained emotional responses (Part I), suggests emotion is involved in the training. Several theories of learning have hinted at a role for emotion. Neurology and psychology now provide experimental evidence that we emotional neurophysiology helps us apply new knowledge to change our assessments and decisions. When simulation practitioners in pursuit of improved decision-making speak of the importance of engagement, they are discussing a concept in which emotion plays an important role.

(See Part I): Iowa Gambling Task: Decisions under conditions of uncertainty, including decisions that we consider primarily rational, are generally driven by emotion.

(See Part I): Implications of Brain Lesions on Knowledge, Skills, and Attitudes: Emotions evolved to facilitate decision-making in an uncertain world.

Emotional Perturbation: Learning only affects performance if it changes future decisions or behavior. Several educational theories have posited that emotion is part of such a change.

Nisbett & Borgida on Inference: We make assessments and decisions based on our understanding of cause and effect. We are not wired to revise that understanding based on data, but on events to which we feel a connection: either personal experiences or stories with a potentially empathetic character.

Making Sense of the Monty Hall Problem: We revise our understanding of principles based on an emotional bump, not based on a rational explanation alone.

Emotional Perturbation
Source: [1]Mezirow, 1997. [2]Segal, 1999. [3]Perkins, 1999. [4]Infed.org.

Moral of the Story: Learning is only useful if at some point it changes future decisions or behavior. Several educational theories have posited that emotion is part of such a change.

Proposed Implication for Simulation: Emotion from the experience of simulation and debriefing likely provokes reflection on suspect assumptions.

In this workshop we are more concerned with experimental psychological evidence that emotion is, in fact, the driver of the change in effective decision-making. However, such ideas were foreshadowed by Lewin's idea of unfreezing as a prerequisite to social change.[4] Authors in education have expanded on the role of an emotional perturbation being the driving force that may on one hand lead to reflection, or on the other hand provoke defense of existing understanding.[1-3] The perturbation is variously described as "disorienting dilemma", "disruption", or "troublesome knowledge".

Experiment discussed in workshop – consider participating in workshop before reading.

Nisbett & Borgida on Inference
Source: [1]`Nisbett, 1975. [2]Kahnemann, 2011.

Moral of the Story: We make assessments and decisions based on our understanding of cause and effect. We are not wired to revise that understanding based on data, but on events to which we feel a connection: either personal experiences or stories with a potentially empathetic character.

Proposed Implication for Simulation: The learning objectives that require engagement are those for which the participant must generalize cause-and-effect from the specific experience in order to affect future behavior. For example, any learner may reply back on a written test that a team leader not doing tasks promotes code team function. An engaged participant may break a habit of doing the first available familiar task in an emergency in favor of ensuring that a team leader is designated.

Background: The "helping experiment" was a prior psychology experiment. It was designed to test whether subjects (who believed the experiment had a different purpose) would help a fellow subject in distress. Each subject knew they were one of six subjects placed in separate rooms, and that only they and the other four healthy subjects could hear the unexpected call for help. The question was how many of the subjects would come out of their room to go to the room of the distressed subject.

Nisbett and Borgida:
The experiment tested whether a causal belief is affected by contrary information.[1,2] Most people think that being an ordinary decent person is enough to cause someone to come out of their room to help. Nisbett and Borgida described the design of the "helping experiment" to students, and showed two videos of 2-minutes each purportedly randomly selected from subjects who had participated. The videos described the subject's major, GPA, hobbies, and goals.

Three groups were given limited or no results and asked to predict the remaining results.
Naive: Students given no information on results
General: Students told (and stated on quiz) that only a few subjects gave timely help
Specific: Students told the two video subjects never helped

Group	Prediction regarding overall result:	Prediction regarding video subjects:
Naive	Most subjects gave timely help	Video subjects gave timely help
General	[Told result]	Video subjects gave timely help
Specific	Few subjects gave timely help	[Told result]

A change in prediction relative to naïve group shows change in understanding. Students surprised by the inaction of a statistically relevant group described it on a quiz but did not reflect on the meaning. They did not learn that ordinary people, possibly including themselves, might not help. Students surprised by the inaction of a tiny sample of people <u>with whom they feel slightly acquainted</u> reflected on the unexpected difficulty of helping. They made different predictions than the naïve group.

Conclusion: We change understanding of cause-and-effect by reflecting on specific cases to which we feel connected (these may be personal experiences). See also the Monty Hall problem.

Extrapolating Further: A disengaged participant can take a better action in a rerun of the same simulation when it is suggested. An emotionally involved participant can change understanding of cause-and-effect to improve performance in related situations.

Making Sense of the Monty Hall Problem
Source: [1]Klein, 2009. [2]Bechara, 1997. [3]Damasio, 1999.

Moral of the Story: We revise our understanding of principles by reflecting after an emotional bump, not based on a rational explanation.

Proposed Implication for Simulation: Whether we change decision-making by learning new options or by revising which of the known options we choose, we are learning which option can be a cause that is most likely to lead to the most desired effect. We learn closed-loop communication by seeing a closed-loop succeed where yelling out to the room in general had failed.

It is best to read Gary Klein's analysis of the Monty Hall problem[1] in an attached appendix before reading this paragraph. His empirical observation is that an authoritative presentation often doesn't perturb our complacence enough to accept the simple, clear explanations he lists at the end; we must be disturbed by an experience. He succeeds by asking questions about the experience. This is contrary to what we would expect if we understood rational principles based on rational explanations.

Doing well on the Iowa Gambling Task[2,3] (IGT: see Iowa Gambling Task) means applying past experience with several specific cards to infer a general principle for selections of future cards. Perhaps there is an analogy between a group of novices with the Monty Hall problem and one group in the IGT study. In the Monty Hall problem, those who haven't had the experience disturb their complacence have trouble applying the explanation they are given to their framing of the problem. In the IGT, those whose brain lesion interferes with disturbance from their sympathetic nervous system have trouble applying past information to their next decision, despite their memory for facts being fully intact.

Conclusion: We change our understanding of how the world works as a result of being provoked to reflect by an emotional response.

Extrapolating Further: The conclusion here is essentially the same as Nisbett-Borgida (see Nisbett & Borgida). Such ideas are widespread in educational theory (see Unfreezing). In essence, Gary Klein's formulation of Monty Hall restates those theories. Nisbett-Borgida and the IGT are remarkable in that they measure how much emotion improves human decision-making in their respective circumstances.

This argues against use of didactic methods to affect behavior such as teamwork under pressure. The statistic that 70% of sentinel events in healthcare involve a communication error is predicted to surprise people and yet be useless in their decision-making in a crisis. It is analogous to the surprising statistics about the helping experiment given by Nisbett and Borgida, and the rational explanations tested by Gary Klein. Understanding and applying a new principle contrary to habitual thinking requires something more personal, such as an experience (Monty Hall) or a story about a character with whom we empathize (Nisbett-Borgida).

Part III: What Is Engagement (step 2)

Overall: Expertise requires application of past experience to situations that are not identical. This means the past learning must be generalized, or a meaning must be derived from an experience. There is experimental evidence that emotion is involved in generalization and deriving of meaning. This further supports the proposition in Part II (What Is Engagement step 1) that when simulation practitioners pursue engagement to improve future clinical performance, they are discussing a concept in which emotion plays an important role.

Transformational Learning: Some branches of transformational learning theory suggest that perturbing experiences can lead to new understanding of meaning or the way the world works.

Generalization: Positive affect promotes the broad cognitive focus we need to generalize from a simulation to other situations.

Meaning: The brain region that integrates past emotions into new decision-making also integrates past experiences into schemas that we use for sense-making in new situations.

Transformational Learning
Sources: [1]Cranton, 2012. [2]Meyer, 2010. [3]Bearman, 2018.

Moral of the Story: Some branches of transformational learning theory suggest that perturbing experiences can lead to new understanding of meaning or the way the world works.

Proposed Implication for Simulation: Emotion may play its most important role in simulation when the educational goals involve changing the participants' understanding of how to be effective. For example, an author of the workshop believed he was an effective team member because he truly valued the contributions of others. With the jolt of a chaotic simulation, he learned he would be more effective by stepping back and asking who is leading the team. It was a new view of how teams work.

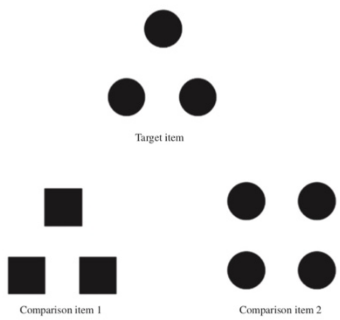
Transformational learning is a large subject in educational literature we do not cover in detail in this workshop.[1,2] We raise the subject at all because it seems fascinating that neuropsychological literature on the following pages suggests something very like the processes that educators have described. It has been explicitly studied in healthcare simulation.[3] The authors of that study note that the 8% of experiences described as transformational is likely a substantial undercount of the contribution of simulation to transformation, as transformation rarely occurs in one event.

Experiment discussed in workshop – consider participating in workshop before reading.

Generalizing
Sources: [1]McConnell, 2012. [2]Bearman, 2018. [3]Dieckmann, 2007. [4]LeBlanc, 2009.

Moral of the Story: Positive affect promotes the broad cognitive focus we need to generalize from a simulation to other situations.

Proposed Implication for Simulation: A simulation can involve negative events and may elicit emotions with negative valence, such as stress. However, a simulation experience is not limited to the events within the duration of the simulation; it also involves expectations, pre-briefing, debriefing, and possibly subsequent reflection and discussion. Extrapolation from the events of the simulation to implications for real-world practice is facilitated by periods of positive affect within the global experience.



Investigators used film clips to evoke positive or negative emotions, then asked subjects which of the bottom figures was more like the top figure. The happier subjects favored the global resemblance of the left figure, whereas the negative film clips promoted focus on detail and selection of the right figure.[1] This illustrates the tendency of positive emotions broaden cognitive focus. Subjects with a positive affect are more likely to recognize the underlying similarity in superficially different puzzles, find new puzzle-solving strategies when needed, and avoid fixation in a healthcare crisis simulation.[1] Conversely, stress narrows focus: moderate stress may improve focused attention and later recall of the source of stress, but stress degrades distributed attention and recall of concurrent events.[4]

The positive affect, however, does not necessarily occur during the scenario. Dieckmann et al. stress that a simulation experience is a social practice, not a pale imitation of reality while the simulation is active.[3] (see Heider-Simmel). A study of 327 narratives describing, “the most powerful learning experience you have had using simulation” as a participant is congruent with generalization being associated with positive affect.[2] 81% of the experiences were characterized by the researchers as “Progress”, and 8% “Transformation”. Both categories tended to be associated with negative emotions paired with highly positive conclusions. Both categories tended to be changes in holistic aspects of managing a situation or one’s self that were still applied to practice years later.

Conclusion: In common usage we discuss whether or not we “feel engaged”. That positive affect promotes broader thinking supports such a role for emotion in engagement. Moreover, engagement can happen in part during the debriefing (see Part IV). Simulation practitioners spend valuable time on promoting a safe environment and respectful debriefing. Now we can explain this isn’t just about Sim Center popularity: it’s about outcomes in learning.

Experiment discussed in workshop – consider participating in workshop before reading.

Meaning

Sources: [1]Lieberman, 2012. [2]Warren, 2014. [3]Spalding, 2015. [4]Schneider, 2017. [5]Kahneman, 2011. [6]Dieckmann, 2007. [7]Rudolph, 2007. [8]Choi, 2017. [9]Bearman, 2018.

Moral of the Story: The brain region that integrates past emotions into new decision-making also integrates past experiences into schemas that we use for sense-making in new situations.

Proposed Implication for Simulation: It's reasonable to suppose that when we integrate a simulation experience into our worldview of decision-making and teamwork that neurophysiology of emotion plays a role in the sense we make of the simulation.

We use schemas based on previous experience to greatly improve both understanding and recall of new experiences. For example, we have a schema for going to a restaurant.[1] We expect that the person standing nearby is waiting for our order, not waiting for an invitation to join us. We later remember having ordered without necessarily recalling the details of the exchange. One published way to test schema use is to test recall of a list of words. For example, if several words fit a coastal schema, people may falsely recall the word "water" because it is congruent, even though it was not in the list.

Normal decision-making support by emotions is impaired by lesions in a specific part of the prefrontal cortex (vmPFC: see Iowa Gambling Task). Patients with such lesions also demonstrate less schema-induced false recall in the word-list test above.[2] A more sensitive study showed these same patients also have less schema-assisted true recall, and, indeed, somewhat abnormal schema formation.[3] By contrast, intelligence, memory, and similar traditional tests of brain function were normal.

Conclusion: By itself, altered schema formation does not imply any role for emotion: the hippocampus, which mediates declarative memory rather than emotion, is vital for schema formation. Schema formation is simply an example of the several ways in which vmPFC has been implicated in integrating past experience to affect future actions. However, emotions are among the data integrated at the vmPFC. Neuroscientists use terms such as "affective meaning" or "subjective value' to suggest the brain mixes facts and emotions to derive the meaning of an experience.[4]

Extrapolating Further: Vomit. Upon reading that, you had a slight sympathetic discharge, your facial muscles twitched slightly toward disgust, and you are now reading this slightly more critically.[5] The word lists used to test schema formation have emotional content; presumably schemas can too. Emotion is part of the meaning of the simulation for the future. As an example of such meaning, Bearman et al conclude their study of powerful experiences by saying, "It may be that [simulation-based education] offers an opportunity for participants to come to understand the role of error in health care over time and to transform thinking about failure to thinking about fallibility."[9]

Dieckmann's[6] suggestion that we perceive realism in three modes continues to be useful.[8] Discussion of physical, conceptual, and emotional/experiential realism[7] is readily understood by example,[*] yet why experiential realism should be separate from the others is challenging to explain. Perhaps viewing the brain as integrating emotions and concepts over the global experience to derive meaning for the future helps articulate experiential realism. (See Generalization)

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[*] Physical: The mannequin wheezes. Conceptual: Ventilator pressures are high, and both wheeze and pressures are improved with albuterol. Experiential: This felt like treating an episode of bronchospasm.

Part IV: How Do We Get Engagement?

Overall: There is experimental evidence that we automatically rationalize our experiences and actions with cause-and-effect stories. This suggests, for example, that when we participate in a simulation, we infer from our observations and experiences why we're there, why the facilitators and other participants take the actions they do, and to some extent, why we act as we do. We can revise these inferences based on new information, such as in debriefing, and interestingly we will also revise our description of the event to suit our inferences. This interaction of sense-making and narrative explains why simulation literature has focused less on physical realism and more on good prebriefing and respectful debriefing.

Episodic Memory: The context and the lessons of a memorable event become associated in our brains.

Heider-Simmel Experiment: We automatically and constantly make cause-and-effect stories to explain our observations.

Confabulation: We adjust facts and stories, including those about our own actions, after the fact so our sense of cause and effect stays intact.

Mannequin Death in Sim: The impact on learning of simulated patient death may relate more to the participants' cause-and-effect story about the global experience than to the fact itself of the death.

Episodic Memory
Source: [1]Boet, 2011. [2]Reader, 2011.

Moral of the Story: The context and the lessons of a memorable event become associated in our brains.

Implication for Simulation: The association of a general principle with the context in which it is relevant makes it easy to retrieve when the context is similar. A memorable simulation is a way to help a principle be applied when it is needed.

Boet et al[1] demonstrated retention of emergency airway skills in anesthetists for at least a year after a simulated airway emergency that eventually progressed to emergency cricothyroidotomy. This is remarkable because previous evaluations of retention of similar skills demonstrated decay in a matter of several months. Both the authors and the accompanying editorial[2] attribute the difference to episodic memory, which connects to the event both the circumstances and the conclusions. Thus, in similar circumstances, the conclusions are readily recalled.

There is previous simulation literature on emotion making lessons memorable, whereas in this workshop we are more focused on the role of emotion in making meaning of the lesson. However, perhaps there is an element of semantics in this distinction, in that associating context with lesson clearly makes it meaningful for the future. Indeed, in the rest of Part IV we discuss the two-way interaction of our narrative of events and sense-making, also suggesting a connection between recall and meaning.

Experiment discussed in workshop – consider participating in workshop before reading.

Heider-Simmel Video
Sources: [1]Kahneman, 2011. [2]Heider, 1944. [3]Dieckmann, 2007. [4]Rudolph, 2014.

Moral of the Story: We automatically and constantly make cause-and-effect stories to explain our observations.

Proposed Implication for Simulation: When we engage a simulation, we do not deceive ourselves that it is the actual situation, we tell ourselves a story of why we choose to treat the simulation as real. The story includes not only whether cause-and-effect in the simulation seems preserved, but our views of the intentions of others. These views may change on reflection and new information.

Heider and Simmel studied the reactions people had to a movie of geometric shapes moving about such that at times two are contacting each other and other times one is following another.[1,2] Most subjects described the movie in terms of personalities and/or intentions. One scene is routinely described as a fight and another as a chase; several times one character opens a door. One triangle is largely seen as a bully. However, there interesting are differences. For example, each of the other two characters is seen variously as courageous, cowardly, or clever, among other traits.

Even though adults watching the movie know they are watching an animation of geometric shapes, they describe what they see as consequences of the personalities of the characters. Similar experiments with different motions were described by subjects in terms of physical causation (one object bumps into another causing the second to move). Experiments with movies of both types with infants less than one year old also suggest that they are surprised when movements appear inconsistent either with physical interaction or inferred character intention. [1]

Conclusion: Apparently, we are wired to constantly infer cause and effect, whether the cause is physical interaction or character intention. We describe this as a cause and effect story.

Extrapolating Further: In their analysis of the theoretical foundations of simulation, Dieckmann et al. stress that a simulation is a social practice, not a pale imitation of real practice.[3] Thus participants' experiences are not determined just by the events within the simulation but also their perceptions of the goals of the activity, of the agreements involved, of how real events are represented, etc.

Describing the global social experience as a cause-and-effect story does not offer radical new ways to promote engagement, it suggests a mechanism underlying the existing practices of experienced simulation practitioners. A good prebriefing describes both the facilitator intention and the "laws of physics" in the simulation world.[4] A successful debriefing develops some consensus on the cause and effect of the events that is applicable for the future. For example, after debriefing participants may agree that the critical change in vital signs was missed in part because the people responsible were all focused on tasks, and not only because the vital signs were written on a whiteboard.

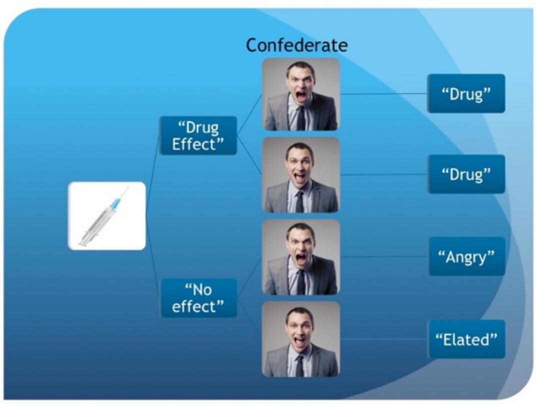
Confabulation
Sources: [1]Lieberman, 2012. [2]Gazzaniga, 2011.

Moral of the Story: We adjust facts and stories, including those about our own actions, after the fact so our sense of cause and effect stays intact.

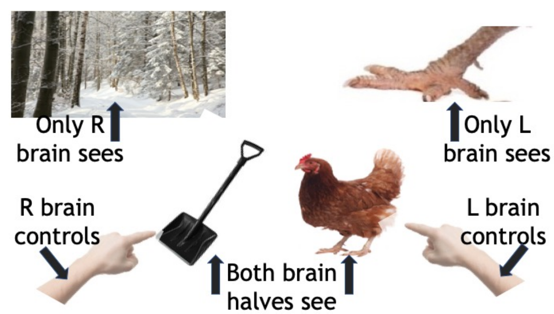
Proposed Implication for Simulation: As simulation participants, we unknowingly adjust our cause-and-effect story afterward to make sense of our actions. Engagement may largely depend on debriefing.

Subjects heard a recording[1] of either: "It was found that the *eel was on the axle," or "It was found that the *eel was on the orange." An identical noise was used at the *, so the sentences only differed in the last word. Nevertheless, subjects clearly heard "wheel" or "peel" congruent with the last word.

A. Subjects were given an adrenaline injection right before going into a room, but were told it was a vitamin. [2] Half were told that there could be no side effects from the shot, and half were told there could. In the room a confederate acted either happy or angry. The subjects told of side effects reported them. The other subjects reported either being elated or furious congruent with the confederate's behavior. In other words, they attributed their pounding heart to their emotions.



A.



B.

B. The two sides of a subject's brain could not communicate directly due to a severed corpus callosum. Only his right brain saw the snowy scene in the left visual field; only his left brain saw the chicken foot in his right visual field. [2] Both sides were shown several other pictures, and he was asked to point to the corresponding picture. His left brain moved his right hand to the chicken; his right brain moved his left hand to the shovel. He was asked why; his speech center (L brain) replied the chicken fits the foot. Then seeing the left hand, it said, "And, of course, you need the shovel to clean the chicken coop."

Conclusion: we reconstruct a causal story for our actions that fits the facts available at the time without being aware we are doing so – and this may be revised as we learn new facts or interpretations.

Extrapolating further: Participants who know the importance of chest compressions may believe the explanation for not having done them is a lack of realism. On learning that knowledgeable providers without sim experience make the same mistake in real situations, they may revise their causal story. Also, we may start a simulation with participants doing routine parts of their job so their own actions endorse a story of an analogy between the simulation and their daily job.

Mannequin Death

Source: [1]Fraser, 2014. [2]Goldberg, 2017. [3]Dror, 2011. [4]Dror, YouTube. [5]Bearman, 2018. [6]LeBlanc, 2009. [7]Truog, 2013. [8]Covetto, 2013. [9]Tripathy, 2016. [10]McBride, 2017.

Moral of the Story: The impact on learning of simulated patient death may relate more to the participants' cause-and-effect story about the global experience than to the fact itself of the death.

Proposed Implication for Simulation: Mannequin death is an area of simulation where the relationship between emotion and learning outcomes has been explicitly debated and studied. The clear consensus of the importance of debriefing suggests that the participants' story of the experience impacts outcome.

Planned simulated death is widely accepted for the learning objective of managing the aftermath; the debate regards simulated patient death depending upon the participants' actions.[8] We do not frame the debate in terms of realism, as realism by itself may either increase or decrease learning.[3,4]

A controlled trial with 116 senior medical students suggested that when the patient was randomized to die following their management, the students had more negative emotions and were significantly less likely to be judged competent in a similar simulation three months later.[1] A randomized controlled trial involved 50 junior anesthesia residents participating in 12 scenarios in which the patient either always died, never died, or died depending upon their actions. Results suggested that invariable death increased stress but variable death improved performance in four test simulations six weeks later.[2]

Given the contrasting results, it is easy to miss that both studies were impressively designed to isolate mannequin death as a variable, and both found statistical evidence that it can impact outcomes. This is clear evidence for the importance of emotion in simulation-based learning. The difference in results suggests that mannequin death is interacting with other variables. This is consistent with evidence that the impact of stress on learning depends on the degree of the stress, the type of learning subsequently measured, and the relationship between that lesson and the perceived source of stress.[6]

Two related studies of focus groups of participants developed models for factors involved in participant responses to mannequin death.[9,10] They identified several factors ranging from the background and preparation of the participants through their impressions of the simulation afterwards. In particular, debriefing emerged as crucially important to resolve both the emotions and the lessons, as anticipated by earlier authors.[7,8] This role of debriefing is reinforced by a study not of mannequin death but of narratives of powerful learning experiences in simulation. [5] The authors suggest that such learning often involves negative emotions with positive resolutions (see Generalization), whereas cases dominated by negative emotions became powerful for learning how ***not*** to use simulation.

Conclusion: In this workshop, simulated death is just an example of an emotional experience, but it's one that demonstrably matters. Rephrasing a suggestion of Truog and Meyer,[7] the positive or negative impact of mannequin death may depend on whether the participants derive a story of gaining new capability or of being a failure. Given that mannequin death occurs during the simulation, identification of variables across the global experience and emphasis on debriefing are consistent with this hypothesis.

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Appendix: Monty Hall by Gary Klein

The below comes from what I regard as a brilliant chapter by Gary Klein in Streetlights and Shadows; the chapter is called Unlearning. He says sure, sometimes the right metaphor for learning is adding to a storehouse of knowledge, but sometimes the right metaphor is a snakeskin - you have to shed your old ideas in order to take on the new ones (this reflects the educational literature of Threshold Concepts).

Now, the caveat: I believe you must do the (brief) exercise, or this whole thing will be meaningless for you. When I did the exercise, I came away feeling that I had learned something critically important about the application of experiential learning and reflection.

And now, word for word, Gary Klein:

"The process of unlearning seems to work best when we go through this type of emotional process. Losing confidence in our mental models permits us to entertain new beliefs."

"Now let's try a demonstration using the Monty Hall problem. If you have looked into this problem in the past and gotten frustrated, or even decided that it was incomprehensible, perfect. That's exactly the attitude I want."

"On Hall's television show Let's Make a Deal, contestants had to guess which of three doors to open. There was something valuable (often a car) behind one of the doors. Each of the other two doors opened to reveal a goat. But there was a gimmick. After the contestant picked a door, Hall would open one of the other doors, invariably revealing a goat. The contestant then had a choice: either stick with the original door or switch. On the surface, this seemed like a 50/50 bet. Two doors remained, behind one of which was a valuable prize. However, it turns out that the odds are much better if the contestant switches."

"Most people can't see why, and they reject arguments trying to explain the advantage of switching. Even prominent mathematicians insist that the odds are 50/50. As far as I can tell, Leonard Mlodinow, in his 2008 book, The Drunkard's Walk, has provided the best explanation about why one should switch. Until now."

[Paul's note: My hypothesis is this demonstration may be even more impressive if you stop and try to explain to Gary Klein, who is a psychologist after all, that he is wrong, the mathematicians are right, it can ONLY be a 50/50 bet - but that's optional.]

"Example 17.3: Explaining the Monty Hall problem We are going to make three passes at the problem. The first pass uses an exercise that relies on experience, the second exercise relies on a question, and the third exercise uses a new frame."

"The experience Place three similar objects in front of you, as shown in figure 17.1 [Paul's note: figure 17.1 shows three squares arranged in a line.] They can be coins, ashtrays, sticky notes, or whatever is handy. These objects represent the three doors on Let's Make a Deal. (Please do the exercise instead of just reading about it. It makes a difference.)"

"We're going to go through this two times. The first time, you will stick with your first choice and we'll see what happens when the prize is behind each of the doors. The second time you will shift from your first choice, and again we'll see what happens when the prize is behind each of the doors."

"To save time, throughout this exercise you are always going to pick door 1 on the left. (See figure 17.1.) [Paul's note: no, you don't need figure 17.1, and if you thought you did, then I respectfully hypothesize you are trying to do this experiment in your head and I respectfully ask you again to actually do it with the three objects.] It's easier to explain this way rather than doing all the permutations."

"Let's start the first set of three trials, where you stick with your initial choice, door 1."

"For the first trial, find another object, perhaps a small packet of sweetener, to represent the prize, and put it on door 1. Now, you picked door 1 and the prize is behind door 1. As a stand-in for Monty Hall, I open one of the other doors (it doesn't matter which, because neither has a prize behind it), you stick with you original choice, and you win. Congratulations."

"In the second trial, the prize is behind door 2. Move the marker behind door 2. You pick door 1, I open door 3 (showing that there isn't a prize behind it), you stick with door 1, and you lose. Too bad."

"In the third trial, the prize is behind door 3. Move the marker over there. You pick door 1, I open door 2 (no prize), you stick with door 1, and again you lose. So by sticking with your original choice you win one out of three times. Those are the odds you would expect."

"Now let's go through the drill a second time. This time, you are always going to switch."

"In the first trial, the prize is behind door 1. Move the marker back. You pick door 1, I open one of the others. It still doesn't matter, but suppose I open door 2. You switch. You aren't going to switch to door 2, because I've already shown that the prize wasn't there, so you switch to door 3. I open all the doors, and the prize is behind door 1, your original choice. You lose, and you feel like a chucklehead for switching."

"In the second trial, the prize is behind door 2. Move the marker over. You pick door 1. I open door 3, which doesn't have a prize. You switch. Obviously you won't switch to door 3, because I've already shown that the prize wasn't there. So you switch to door 2 and you win."

"In the third trial, the prize is behind door 3. Move the marker over (this is the last time, if you're getting tired). You pick door 1. I open door 2. You switch to door 3, and you win again."

"Thus, when you stuck with your original choice you got the prize one out of three trials. When you shifted you got the prize two out of the three trials. If that doesn't convince you, we'll go to the next exercise."

"The questions The first question in this exercise is "Why was switching successful two out of three times, whereas sticking with your original choice was successful only one out of three times?"

"Here is another question: With three doors available, I am giving you a lot of information by opening one of them before you make your final choice. In the experience we just went through, when you stuck with your original choice did you make any use of that information?"

"If after pondering this question you still aren't convinced, we'll continue to a third exercise."

"The new frame   Let's change the set-up. Suppose that after you chose door 1, I offered you both of the remaining doors. If the prize was behind either the middle door or the door on the right, you would win. Would you stick with door 1, or would you take the two remaining doors? (Hint: Your odds seem much better if you can choose two doors than if you choose just one.) Now, is there any difference between an option in which I offer you two doors versus an option in which I open one door that doesn't have a prize behind it and offer you the remaining door?"

"I find that these three exercises convince most people, even skeptics who had announced that nothing was going to change their mind. Notice that I began with the experience. The purpose of the experience is to force you to doubt your mental model about the 50/50 odds. As long as you still have some faith in that 50/50 model, you are going to be hard to convince. So I need the experience to get you to give up faith in the 50/50 mental model. You have to unlearn your initial mental model before you can adopt a better one."

"And also notice that I haven't provided any explanation at all. That's why my approach is so convincing."

"When the Parade columnist Marilyn vos Savant pointed out that switching made more sense than sticking with the initial choice (1990, p. 13), she explained that if you switch then you win if the prize is behind door 2 or door 3. You will win either way because of the hint. But if you don't switch, you will win only if the prize is behind door 1. This succinct explanation left Marilyn vos Savant's readers unconvinced."

"Complex learning isn't simply a matter of adding additional beliefs, as in the storehouse metaphor. Rather, we have to revise our belief system as we experience failures and admit the inadequacy of our current ways of thinking. We discover ways to extend or even reject our existing beliefs in favor of more sophisticated beliefs. That's why it might be useful to replace the storehouse metaphor for learning with the snakeskin metaphor."