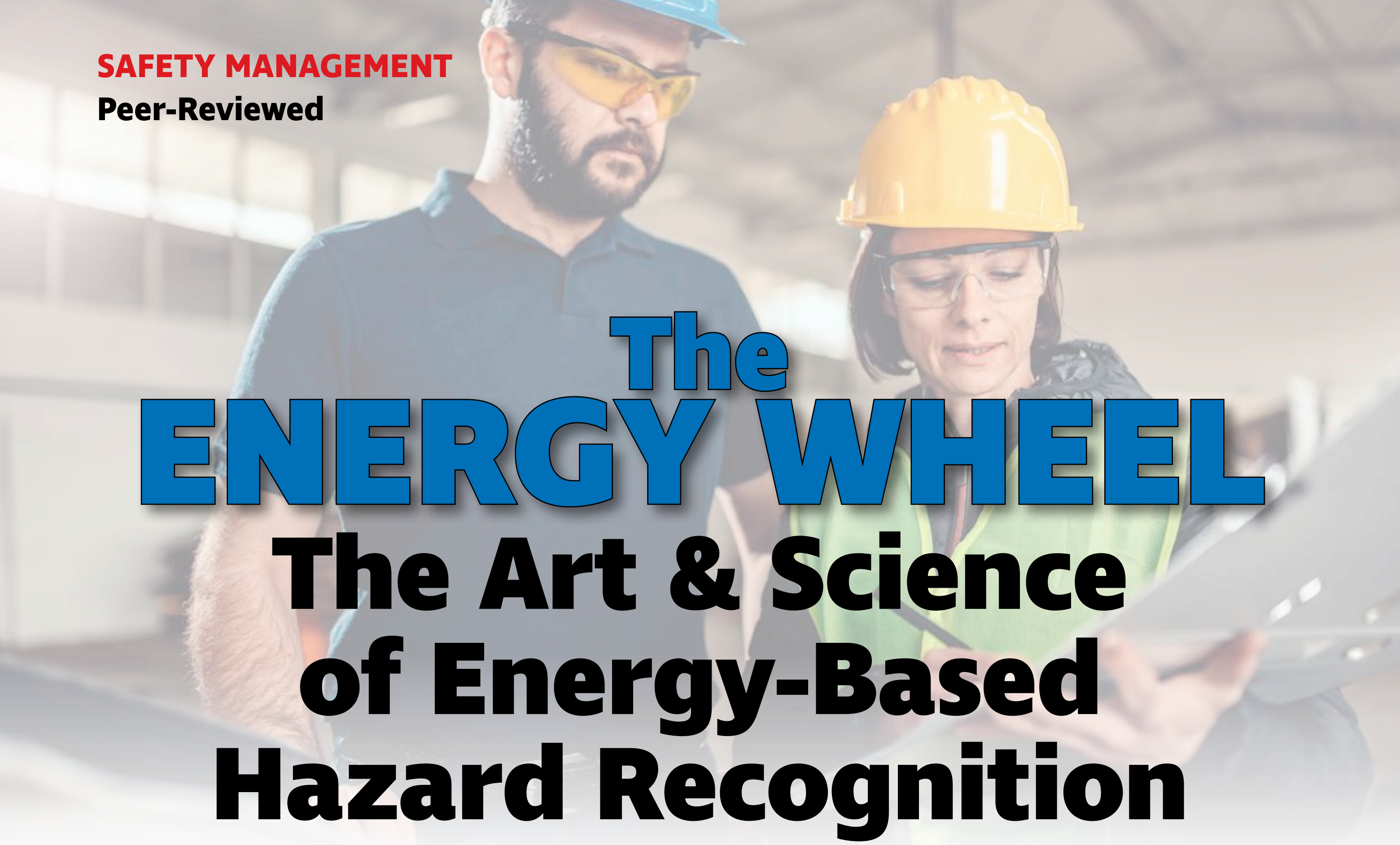

The ENERGY WHEEL
The Art & Science of Energy-Based Hazard Recognition

By Matthew R. Hallowell

HAZARD RECOGNITION IS A VITAL SKILL required for nearly every safety activity. For example, it is required to successfully complete prejob safety briefings, safety observations and even prevention through design reviews. Although the profession has made tremendous progress in safety management over the past 50 years, most safety practices are built on the implicit assumption that workers can see hazards that are present and anticipate those that may emerge. However, recent research suggests that hazard recognition skills may not be as strong as originally assumed (Albert, Hallowell, Skaggs et al., 2017).

As organizations have improved their incident learning, hazard recognition has emerged as a root cause in about half of all incidents (Alexander et al., 2017; Haslam et al., 2005). Because hazards can be so obvious in retrospect, many historical incident investigations ended with the conclusion that the workers were complacent or negligent (i.e., they saw the hazard but worked unsafely around it anyway). However, when we consider the context from the worker's perspective *in the moment before an incident occurred*, science suggests that some hazards are overlooked because of blind spots that affect us all (Hu et al., 2018). In other words, what we once thought of as complacency may actually be a predictable biological limitation.

Most scientific understanding of hazard recognition lies in the branch of applied psychology known as situational awareness. Situational awareness is the process of perceiving an important stimulus, understanding its meaning and anticipating outcomes (Endsley, 1995). Translated to the context of safety, this process involves 1. recognizing the presence of a danger (i.e., hazard recognition); 2. judging the level of danger posed by the hazard (i.e., risk perception); and 3. deciding how to behave around the hazard (i.e., risk tolerance). This model of situational awareness is presented in Figure 1.

Interestingly, the academic community has created a wealth of understanding about risk perception, risk tolerance and safety behavior, but, until recently, comparatively little was known about how a person identifies a hazard in the first place. This is critical knowledge because risk perception, risk tolerance and behavior are irrelevant if the associated hazard is not identified.

Fortunately, hazard recognition research has accelerated in the past decade. Field experiments have uncovered the types of hazards that people commonly miss, and laboratory research

KEY TAKEAWAYS

- **In prejob safety briefings, workers identify only about 45% of the hazards they face during the work period. Hazard recognition blind spots are consistent and predictable, regardless of trade, experience or education.**
- **Hazards that are easily identified (e.g., gravity, motion) are recognized instinctually and require comparatively low cognitive effort. Hazards that are most often missed (e.g., mechanical, pressure, chemical) are processed in the cerebrum and require relatively high cognitive effort.**
- **Field experiments showed that using the energy wheel improves hazard recognition by approximately 30%. The energy wheel is effective because it provides a simple set of reminders to search for commonly overlooked hazards.**

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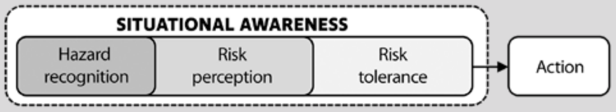
FIGURE 1
SITUATIONAL AWARENESS

Hazard recognition is the first step in situational awareness.



has helped to explain why. This new knowledge was used to design and experimentally test new interventions that have made dramatic improvements. This article summarizes this body of research and explains why energy-based hazard recognition has tremendous potential across industries, sectors and trades.

Using an aggregated body of research, this article addresses the following questions:

1. How good are we at hazard recognition?
2. Which types of hazards are we most likely to see and which are we most likely to miss?
3. Why are some hazards easy to identify while others are often overlooked?
4. What is the energy wheel and why does it work?
5. How has the energy wheel been tested and scientifically validated?
6. What have we learned from using the energy wheel in practice?

General Approach

This study combines the knowledge gained from the review of scientific literature across multiple domains including safety, engineering, psychology and neuroscience. Recent peer-reviewed research has quantified hazard recognition skill, provided insight into the neurological processes of hazard recognition and indicated how specific interventions such as the energy wheel improve skill. To provide practical context, original data are also provided to reveal tangible trends in hazard recognition that are linked to visual examples.

Hazard Recognition Skill

Unlike risk perception and tolerance, hazard recognition is understood as a skill that can be readily improved through targeted interventions (Bhandari et al., 2020). Hazard recognition skill is most commonly measured by comparing the number of hazards that a crew identifies preceding the work period to the number of hazards actually encountered during the work period. For example, Albert, Hallowell and Kleiner (2014a, 2014b), and Albert, Hallowell, Kleiner, Chen et al. (2014) measured hazard recognition skill by applying Equation 1 to data collected from 4,800 worker-hours of field observations from 12 different construction trades. The results indicated that the average hazard recognition skill was approximately 45%, meaning that construction crews identify and discuss less than half of the hazards that they face. These results are similar to those found in an earlier study by Haslam et al. (2005).

Equation 1: Measuring hazard recognition skill

$$Hazard\ recognition\ skill\ (\%) = \frac{No.of\ hazards\ identified\ prior\ to\ work}{No.of\ hazards\ encountered\ during\ work}$$

Hazards are typically missed for one of two reasons: 1. The hazard was detectable, but the individual was not able to identify it; or 2. the hazard was not reasonably detectable given the information available at the time (Figure 2). For example, many workers miss detectable hazards such as pressure vessels and cable tension that are integral components of the planned work. However, other hazards are missed when they emerge from unforeseen change (e.g., a subcontractor unexpectedly staging materials above a workspace, uncovering an error in the design, or unexpected weather). Although one could argue that all hazards are identifiable with strong planning, the data show that hazards associated with change are not always reasonably identifiable before work begins.

Energy Theory

As will be discussed, many of the trends associated with hazard recognition relate to the concept of energy. Attributed to Haddon (1973), the energy theory is based on the observation that all injuries are the result of some undesirable contact between a person and one or more sources of energy. In accordance with this theory, a hazard is more precisely defined as a source of energy that could cause injury, illness or death. Hazards have been conceptualized according to the type of energy they represent (e.g., gravity, motion, mechanical, electrical, pressure).

This concept has been discussed previously in the professional literature, most notably in Fleming and Fischer (2017) who summarized energy-based hazard recognition and provided several conceptual scenarios that illustrate how energy causes harm and the important role of barriers. The present study builds upon but departs from this initial introduction by reviewing recent scientific literature that explains hazard recognition trends that relate to energy, neurological evidence that explains why certain types of energy sources are identified and others are not, and field-based experiments that show the effectiveness of using energy-based hazard recognition tools to improve skill.

Strengths & Limitations in Hazard Recognition

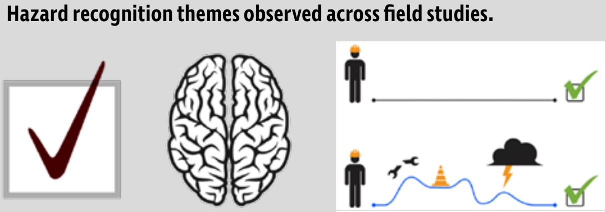
Albert, Hallowell, Skaggs et al. (2017) sought to understand which types of hazards are commonly identified and which are commonly missed. The study revealed strong trends based on the type of energy associated with the hazard. For example, the researchers found that construction workers across trades were more likely to identify gravity and motion hazards and comparatively less likely to identify mechanical, pressure and temperature hazards. To validate these findings and provide tangible and visual examples for practicing professionals, the following new data were collected for this article.

Data Collection Method

To identify and communicate visual examples of the trends in hazards recognized, empirical data were collected from 563 construction workers over 25 individual workshop sessions. At the beginning of each session, participants were shown the three images that appear in Figure 3 before any discussions were held or training was provided. Participants were instruct-

FIGURE 2
HAZARD RECOGNITION THEMES

Hazard recognition themes observed across field studies.



45% of hazards are identified

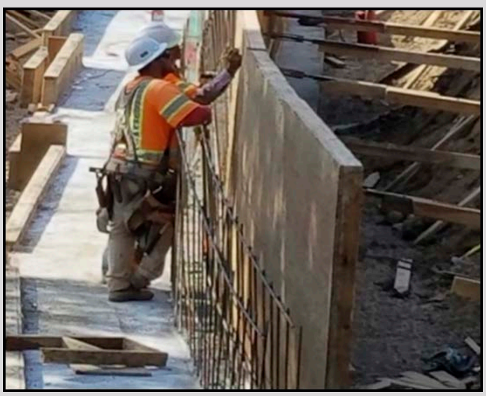
35% of hazards are missed because of cognitive "blind spots"

20% of hazards are missed because they are not reasonably identifiable before work starts

FIGURE 3

HAZARD RECOGNITION TRENDS FOR THREE CASE SCENARIOS

The three images shown to study participants appear below. For each image, the hazards most commonly identified are listed in the average order in which they are identified. The percentage of study participants who identified each hazard and the energy classification for each hazard are also provided.

Case image	Hazards identified	% ID	Energy source
	1. Suspended load	100%	Gravity
	2. Pipe supports (left)	98%	Gravity
	3. Pipe supports (right)	96%	Gravity
	4. Uneven surface	87%	Gravity
	5. Heavy machinery	79%	Motion
	6. Traffic	75%	Motion
	7. Power lines	65%	Electrical
	8. Welding (heat)	35%	Temperature
	9. Hot weather	20%	Temperature
	10. Welding (light)	5%	Radiation
	1. Trip hazards	98%	Gravity
	2. Wall support	95%	Gravity
	3. Leading edge	90%	Gravity
	4. Uncapped rebar	78%	Gravity
	5. Uneven surface	60%	Gravity
	6. Unsupported soils	38%	Pressure
	7. Sharp objects	18%	Motion
	8. Heavy tools	12%	Gravity
	9. Canister	8%	Pressure
	10. Sun exposure	4%	Radiation
	1. Rolling pipe	96%	Motion
	2. Unsupported pipe bell	94%	Motion
	3. Dust	94%	Motion
	4. Traffic	90%	Motion
	5. Uneven surface	87%	Gravity
	6. Excavator bucket	85%	Motion
	7. Dozer	84%	Motion
	8. Dust	66%	Chemical
	9. Cable tension	23%	Mechanical
	10. Hot saw blade	2%	Temperature

ed to individually scan the three images for approximately 2 minutes each and identify as many hazards as possible. They were also asked to circle each hazard and write the order in which it was identified. That is, they were asked to circle and label the first hazard they saw with a 1, the second with a 2 and so on. This information helped to identify which hazards caught their attention first, which were seen later in the scan and which were missed entirely.

These sessions took place at training facilities located throughout the U.S. and Canada. Workers represented a wide range of construction trades including pipefitters, powerline workers, carpenters, mechanics and equipment operators. In total, 23 different trades were represented, and worker experience ranged from 0 to 43 years, with an average of 8 and a standard deviation of 3.8.

Results

The 10 hazards most commonly identified in each image are shown in Figure 3 in the average order in which they were identified. The percentage of workshop participants who recognized each hazard is indicted in the % ID column. Analysis of variance (ANOVA) was used to test for differences in hazard recognition skills among trades, and linear regression was used to determine whether there is any relationship between years of experience and hazard recognition. Interestingly, the results revealed no differences in the number or type of hazards recognized among trades (p-value > 0.3) or correlation with years of experience ($R^2 > 0.10$). In other words, the results revealed that people tend to see the same hazards in approximately the same order regardless of their background or experience. These findings corroborate those found by Albert, Hallowell, Skaggs et al. (2017), who identified consistent patterns in hazard recognized in field studies that transcended geography, trade and employer.

An analysis of the hazards identified in Figure 3 (p. 29) revealed trends that relate the type of energy, similar to those found by Albert, Hallowell, Skaggs et al. (2017). For example, the hazards most commonly identified were related to gravity and motion such as suspended loads, uneven work surfaces, and moving equipment or vehicles. Hazards commonly missed were associated with other energy sources such as pressure, mechanical and temperature.

KERKEZ/ISTOCK/GETTY IMAGES PLUS

The concept of energy offers a new perspective that enables a more scientific understanding of hazards.

Why Are Some Hazards Identified & Others Overlooked?

Since the trends transcended experience and background, it can be expected that there may be biological drivers at play. To design and implement interventions that help to improve hazard recognition performance, it is important to understand how the brain processes hazards of different types. Until recently, little was known about how the brain identifies workplace hazards. Fortunately, recent research examined how the brain functions when identifying hazards and has, again, found trends related to the concept of energy. Before examining these empirical results, a brief set of thought experiments are presented to connect the reader to logical patterns in cognition.

Thought Experiments

A few thought experiments are presented here to show how the type of hazard and the context of the environment may influence hazard recognition. Thinking through and comparing the following cases provides insight into the impetus for subsequent experimental research.

For each case example, ask the following questions:

•Would a person see this hazard by instinct?

•What training and thought processes are needed to truly understand the hazard?

•What might a person's emotional and/or physiological response be if they were near the hazard (e.g., heart and breathing rates, anxiety or fear, tendency to move away and resist exposure)?

Case A presents an unprotected exposure to a 50-ft-high fall hazard at the top of a large building. The individual is placed at the edge and is asked to look down at the ground below.

Case B presents an unprotected exposure to a 20-ft-deep, clear-cut excavation wall of sandy-clayey soil. The individual is placed at the bottom of the excavation and asked to reach out and touch the soil wall.

Case C presents a contractor drilling a test boring. The engine is on, the auger is rotating, and the soil spoils are rising. The individual walks onto the site while the operation is underway.

Case D presents a contractor drilling a test boring. The engine is on, but the auger has become stuck on a dense clay layer and is no longer spinning. The individual walks on this site before anyone has begun to address the concern.

Comparison of Case A & Case B

It should be clear to a well-trained professional that, in both Case A and Case B, the individual is exposed to a hazard with the potential for fatal consequences. However, we can imagine the reactions to be substantially different in each case. For Case A, we can reasonably assume that nearly anyone would identify that they are in a dangerous situation, and many would experience fear, anxiety, elevated heart rate, weakness in the legs or even nausea.

However, the reactions to Case B are likely to be quite different. Although the scenario is potentially fatal if the soil wall were to collapse, an individual may fail to understand the seriousness of the hazard, and even well-trained workers are unlikely to experience the same intense emotional and physiological response as in Case A.

This case comparison raises the question, if both cases involve potentially fatal hazards, why do we tend to have a physiological and emotional response to one but not the other?

Comparison of Case C & Case D

This comparison offers an opportunity to examine how, even with the same hazard, subtle changes can significantly influence how it is perceived or even recognized. For Case C, the only information needed to identify the hazard is the motion of the auger. For Case D, however, a person would need to piece together clues to determine that the situation is hazardous, such as the engine is on, but the blade is not spinning; the engine laboring; there is a camber or vibration of the auger; or possibly an unusual smell. Processing this information requires experience, problem solving and much more mental effort. One could even understand how someone might not identify the danger at all.

Although the only difference between these cases is the motion of the auger, this one difference can strongly influence how the hazard is identified and processed. This case comparison raises the question, why does one change (motion) significantly influence how we process the hazard?

Empirical Research

Aligned with the thought experiments, Hu et al. (2018) conducted experimental research that may explain how the type and context of a hazard influence cognition. In that study, functional near infrared spectroscopy (fNIRS) was used to measure oxygen consumption in the brain during hazard recognition tasks. fNIRS is a noninvasive optical imaging technique that measures changes in hemoglobin concentrations within the brain (Naseer & Hong, 2015). This process allows functional imaging of brain activity (or activation) by monitoring blood oxygenation and blood volume in the brain. The imaging and associated data provide neurological insight into the parts of the brain that are activated when identifying specific hazards and how cognitively demanding the task is for the individual.

The research by Hu et al. (2018) revealed very strong evidence that commonly identified hazards (e.g., gravity, motion) are identified instinctually and require comparatively low mental effort. Specifically, the fNIRS results showed that recognizing gravity and motion hazards requires very little oxygen and the cognitive processing occurs quickly. This suggests that gravity

FIGURE 4
THE ENERGY WHEEL

Each of the 10 icons in the energy wheel represents a different type of energy. Although not strictly scientific, the icons represent the most common ways that energy manifests at work.

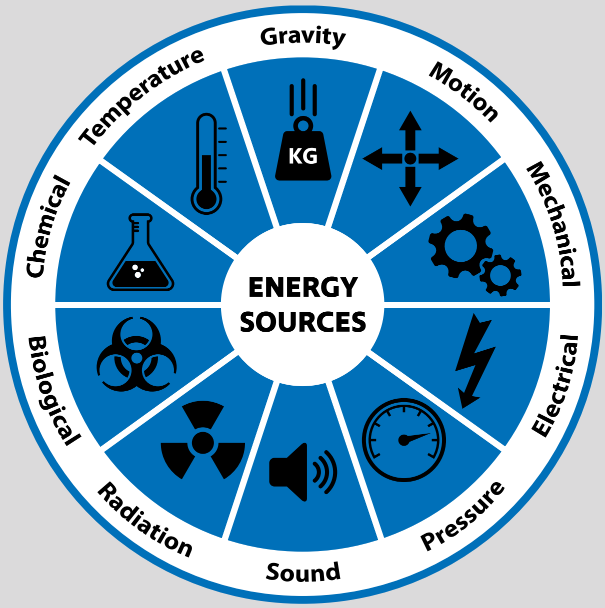


TABLE 1
UNDERSTANDING ENERGY WHEEL HAZARDOUS ENERGY SOURCES

Definition and examples of the 10 hazardous energy sources in the energy wheel.

Energy category	Definition	Examples
Gravity	Force caused by the attraction of mass to the earth	Uneven work surface, work at height, unsecured materials, overhead support structures
Motion	Change in the physical position or location of objects or substances	Traffic, mobile equipment, projectiles, dust particles
Mechanical	Working parts of a machine or assembly, including rotation, vibration, tension or compression	Auger, cable, chain fall, angle grinder, gears, pullies
Electrical	Presence of electrical charge or current	Wires, power lines, power tools, extension cords, transformer, relay
Sound	Audible vibration caused by the contact or two or more objects	Heavy machinery, pile driving, power tools, nail gun
Pressure	Liquid or gas compressed or under vacuum	Pneumatic tire, piping system, tank, hydraulic lines
Temperature	Intensity of heat in an object or substance	Friction, engines, sudden pressure change, steam
Chemical	Toxic objects or substances that pose health risks	Solvents, engine exhaust, silica, wood dust, liquid concrete
Radiation	Objects or substances that emit electromagnetic waves or subatomic particles	Welding, sun exposure, X-ray testing, radioactive waste
Biological	Living organisms or viruses	Bees, snakes, alligators, bears, restrooms

and motion hazards are processed in the amygdala, the location of the brain responsible for our fight or flight response and perception of core emotions (Cahill et al., 1996). Activation of the amygdala is also associated with physiological responses because the amygdala sends a distress signal to the hypothalamus, which triggers the sympathetic nervous system and adrenal glands, thereby releasing adrenaline into the bloodstream (Banich & Compton, 2018).

Alternatively, hazards that are most commonly missed (e.g., mechanical, pressure, chemical) are processed in more advanced locations of the brain and require much greater cognitive effort (Hu et al., 2018). The fNIRS results showed that these hazards require much longer processing times and elevated oxygen demand. This suggests that they are processed by the temporal lobe of the cerebrum, the part of the brain that is responsible for memory, sequencing and complex problem-solving (Banich & Compton, 2018).

Simply put, the hazards we see first and most often are processed instinctually with minimal cognitive effort and those that we commonly miss are identified through complex problem-solving that requires relatively high cognitive effort. To conserve energy, the brain focuses on hazards that are less demanding at the expense of those that require more energy and effort. Because cognition is deeply rooted in our human biology, it is not surprising that the observed trends are consistent despite personal differences.

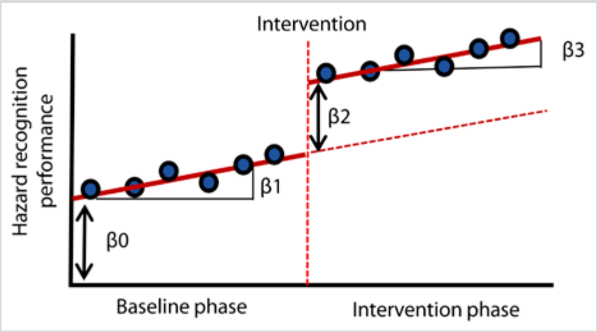
If we revisit the thought experiments, it is unsurprising that the gravity and motion hazards in Cases A and C would be processed in the amygdala. The instinctual identification of the hazard and primitive emotional and physiological responses are clues that the amygdala is responsible for processing the information. Alternatively, the hazards in Cases B and D are processed in the cerebrum and require comparatively high cognitive effort. The high levels of oxygenation observed in fNIRS for these hazards suggests that they are processed in the temporal lobe of the cerebrum. Unlike the amygdala, the temporal lobe is not directly connected to the activation of the nervous system, which explains why exposure to these hazards is not accompanied by a fight or flight response. A possible exception is when an individual has experienced an injury from the hazard in the past (e.g., being caught in a collapsing soil wall, being struck by an auger that released stored energy). In this situation, the emotional connection to the hazard may activate the amygdala and the associated physiological responses (Adolphs et al., 1995).

The Energy Wheel

We have long had a general and abstract understanding of a hazard. In fact, the word hazard is simply defined by Merriam-Webster as "a source of danger." The concept of energy, however, offers a new perspective that enables a more scientific understanding of hazards. In an occupational setting, energy

FIGURE 5
RESULTS FROM TESTING ENERGY WHEEL USE ON ACTIVE WORK SITES

Multiple baseline experimental approach with interrupted time-series regression. Note: β0 refers to initial hazard recognition performance; β1 refers to the existing learning curve that exists before the intervention; β2 refers to the step change that occurs as a result of the intervention; and β3 refers to the learning curve after the intervention.



is required to lift, transport and assemble materials, and can be stored or transferred by hoists, cranes, cables, equipment and tools. Additionally, some materials possess stored energy in their natural state that may be released in the act of performing work (e.g., excavating a trench), and workers themselves have energy by virtue of their elevated center of gravity when upright.

Because energy can be abstract, it is best communicated as the simple forms in which energy commonly occurs on site. This was the inspiration for the energy wheel. Often attributed to the initial efforts of Chevron Corp., the different types of energy were organized into the energy wheel (Figure 4, p. 31). The energy wheel has 10 icons, each representing a different type of energy. Although not strictly scientific, the icons represent the most common ways that energy manifests at work. Table 1 (p. 31) provides a definition and example of the 10 energy sources in the wheel. The definitions are intended as practical interpretations of each energy source rather than a precise scientific definition.

When using energy to identify hazards, the energy wheel serves as a set of reminders to scan for hazards associated with each form of energy. For example, a crew may use the mechanical icon as a prompt to identify rotating machinery, tension in cables, vibration from tools and other hazards.

Effect of the Energy Wheel on Hazard Recognition Performance

The energy wheel is one of the few safety interventions to undergo independent, controlled experimental testing on active work sites. Albert, Hallowell and Kleiner (2014a, 2014b), and Albert, Hallowell, Kleiner, Chen et al. (2014) tested the energy wheel with construction workers across the U.S. through a series of multiple baseline experiments that involved longitudinal data collection and analysis using interrupted time-series regression models (Figure 5). Put simply, the method used involves measuring baseline hazard recognition performance over time by applying Equation 1 (p. 28). Then, at a randomly selected time, the energy wheel training was provided, and crews were asked to use the energy wheel during prejob safety briefings moving forward. Afterward, the crews were observed post-intervention. Multiple crews were studied simultaneously, and the timing of the intervention was randomized and staggered. In this way, the impact of the intervention was statistically isolated and distinguished from other potentially confounding factors. The results were consistent and unambiguous: The energy wheel improves hazard recognition skills by an average of approximately 30%.

Best Practices for Energy Wheel Implementation

Over the past few years, the author and colleagues have delivered workshops on energy-based hazard recognition research to approximately 10,000 workers and their safety leaders. Also, in collaboration with their employers, the author and colleagues have pilot tested the energy wheel in the field, designed long-term implementation strategies and observed the use of the energy wheel over both short and long time frames. These years of observation have revealed several best practices, outlined here.

1. The energy wheel helps us to do what we already do better. The energy wheel is not a safety practice in its own right, and it is not yet another safety activity. Instead, it is a tool that can be used to support any safety management practice that involves recognizing or anticipating hazards. By providing simple reminders that activate broader thinking, the energy wheel makes us more effective at this fundamental skill.

2. The energy wheel adds structure and strategy to prejob safety briefs. Prejob safety briefings are a cornerstone of most effective safety programs. Traditionally, these meetings occur immediately prior to work and involve 1. breaking down the job into discrete steps; 2. identifying the hazards associated with each step and the environment; and 3. identifying the safe work practices that mitigate exposure. Although there is great variability in how prejob safety briefings are performed, hazard recognition (step 2) is typically random and unstructured in nature. That is, when crews discuss the hazards associated with the job, whatever comes to mind first is discussed, recorded and addressed. The energy wheel helps add structure and strategy to this activity by reminding workers to think about mechanical, chemical, temperature, radiation and other hazards that might not come to mind naturally.

3. Prejob safety briefs are not the only application of the energy wheel. Since not every hazard can be anticipated before work begins, OSH professionals must enable the workforce to regularly scan for hazards that have emerged and recognize whether conditions have changed. The energy wheel can help guide this process by providing clearer understanding of hazards and when change is relevant (e.g., we can ask, is a new source of energy present that we did not originally anticipate?).

4. Use instinct first, then use the energy wheel. OSH professionals often lose sight of the fact that workers are able to identify and anticipate about half of all hazards without extra tools or resources. Thus, the most effective approach is one where the crews use their instinct and experience first. Then, once they have exhausted their brainstorming, the energy wheel can be used as a reminder to think about hazard categories that may have been overlooked. Using the energy wheel this way leverages workers' innate strengths and strategically addresses known limitations.

5. Do not change the paperwork right away. A common reaction is to reform safety paperwork to align with the energy theory. This may be an effective strategy in the long term once the concept of energy is widely understood and applied; however, in the short term, abrupt changes to the paperwork can detract from the job safety analyses, observations and other core safety techniques that have been built and refined over many years. Gradual changes to documentation should be considered only once the workforce is accustomed to the energy method and any changes should be informed by recommendations from the field.

6. Energy categories themselves are not hazards. As crews learn about hazards as sources of energy, a common misstep is to start labeling hazards by their energy category. For example, simply calling a rotating piece of equipment mechanical removes important detail from the discussion and adds an undesirable layer of abstraction. Employees should discuss hazards as specifically as possible and be reminded that the energy sources are categories, but not hazards in their own right.

7. The energy wheel can support meaningful conversation and sharing of tacit knowledge. Perhaps the biggest impact that the energy wheel has on safety culture is the improvement of informal safety discussions. When more experienced workers describe how an energy source works and how it can cause injury, the discussion offers an opportunity to share tacit safety knowledge that would not occur if the discussion was limited to commonly identified hazards.

Conclusion

Hazard recognition is a fundamental skill required for nearly every safety activity. Unfortunately, research has shown that work crews typically identify and discuss less than half of the hazards that they encounter. Field research has revealed that work crews are adept at recognizing hazards associated with gravity and motion such as falls from height, suspended loads, uneven work surfaces and mobile equipment. However, hazards associated with other forms of energy such as tension, compression, chemical, temperature and radiation are more commonly missed. These trends transcend industry, trade, age and level of experience.

To understand why some types of hazards are identified and others are overlooked, brain imaging research has shown the part of the brain that is activated and cognitive load required for different hazard types. This research revealed that commonly identified hazards such as gravity and motion require comparatively little cognitive effort because they are processed instinctually in the amygdala, the part of the brain responsible for fight-or-flight response. Alternatively, hazards that are more commonly missed tend to require much higher cognitive effort because they are processed in the cerebrum, the part of the brain that is responsible for complex thought and decision-making.

Fortunately, the energy wheel is a simple but effective tool for helping to augment the human brain. By providing reminders of energy sources that are commonly overlooked such as mechanical, pressure, radiation and chemical, the energy wheel helps crew members think more broadly about the dangers in their work environment. The energy wheel has consistently improved hazard recognition skills by approximately 30% across industry sectors and trades. Additionally, field implementation has been rapid because the energy wheel only requires basic training, and the method is not associated with additional safety burden. Although the concept of hazards as energy has existed for quite some time, it was not until recently that the OSH profession understood how effective it is and why it works. Fortunately, the collaborative work between industry professionals and academic researchers has generated evidence that the method is scientifically valid and impactful in practice. **PSJ**

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