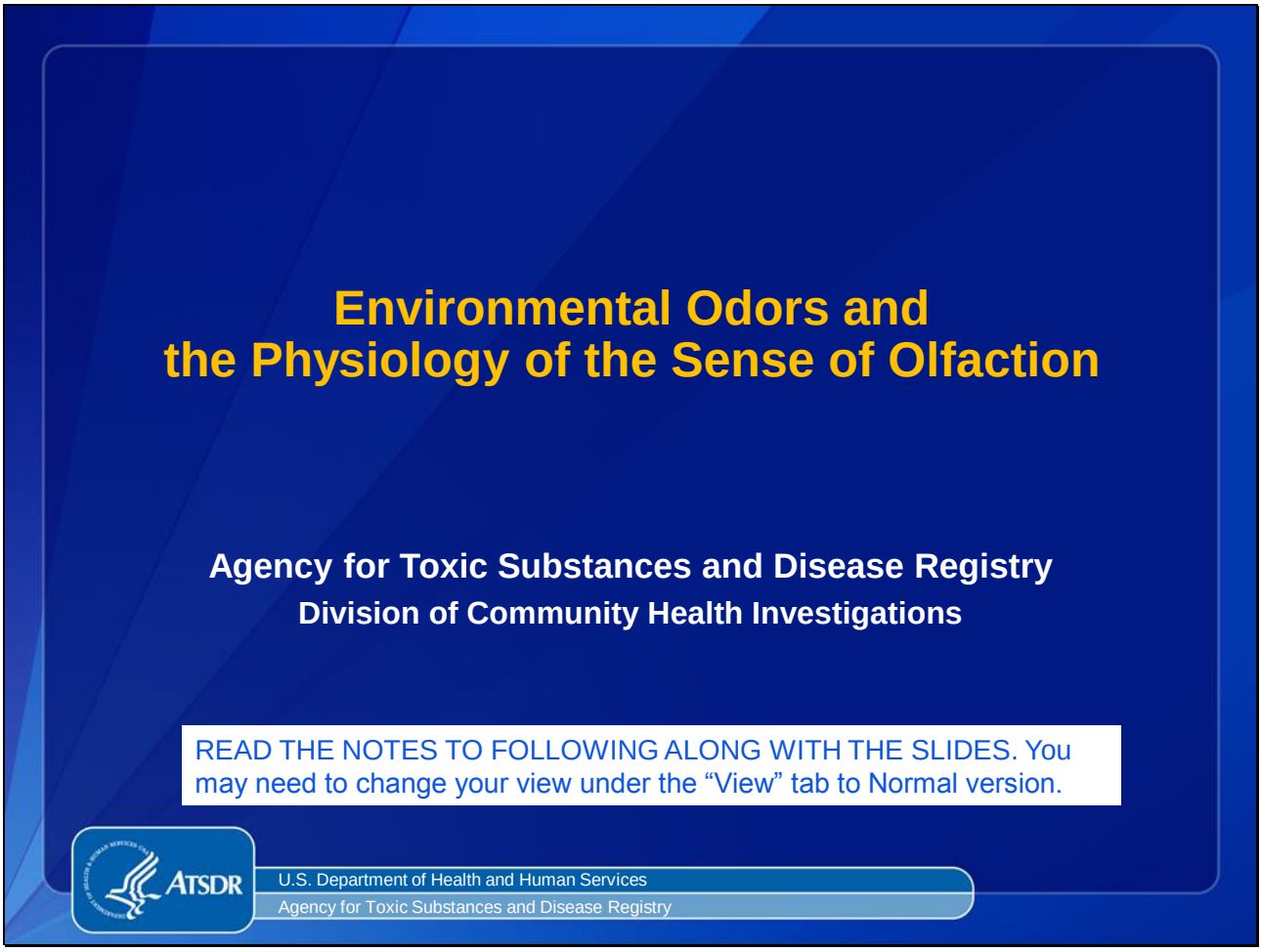
Slide 1



READ THE NOTES TO FOLLOWING ALONG WITH THE SLIDES. You may need to change your view under the "View" tab to Normal version.

Slide 2

Even though most people can smell many hazardous chemicals before they are at harmful levels, community members sometimes feel that their quality of life and sense of wellbeing is decreased because of the environmental odors.

The community complaints tend to be of common health symptoms such as:
-headaches
-Upper respiratory symptoms of nasal congestion
-dizziness
-watery eyes

Slide 3

How much Environmental Odors Should a Community Have to Tolerate?

This questions must be answered before performance standards or any good environmental odor control program can be developed and enforced

Sheffield, R and Bottcher, R

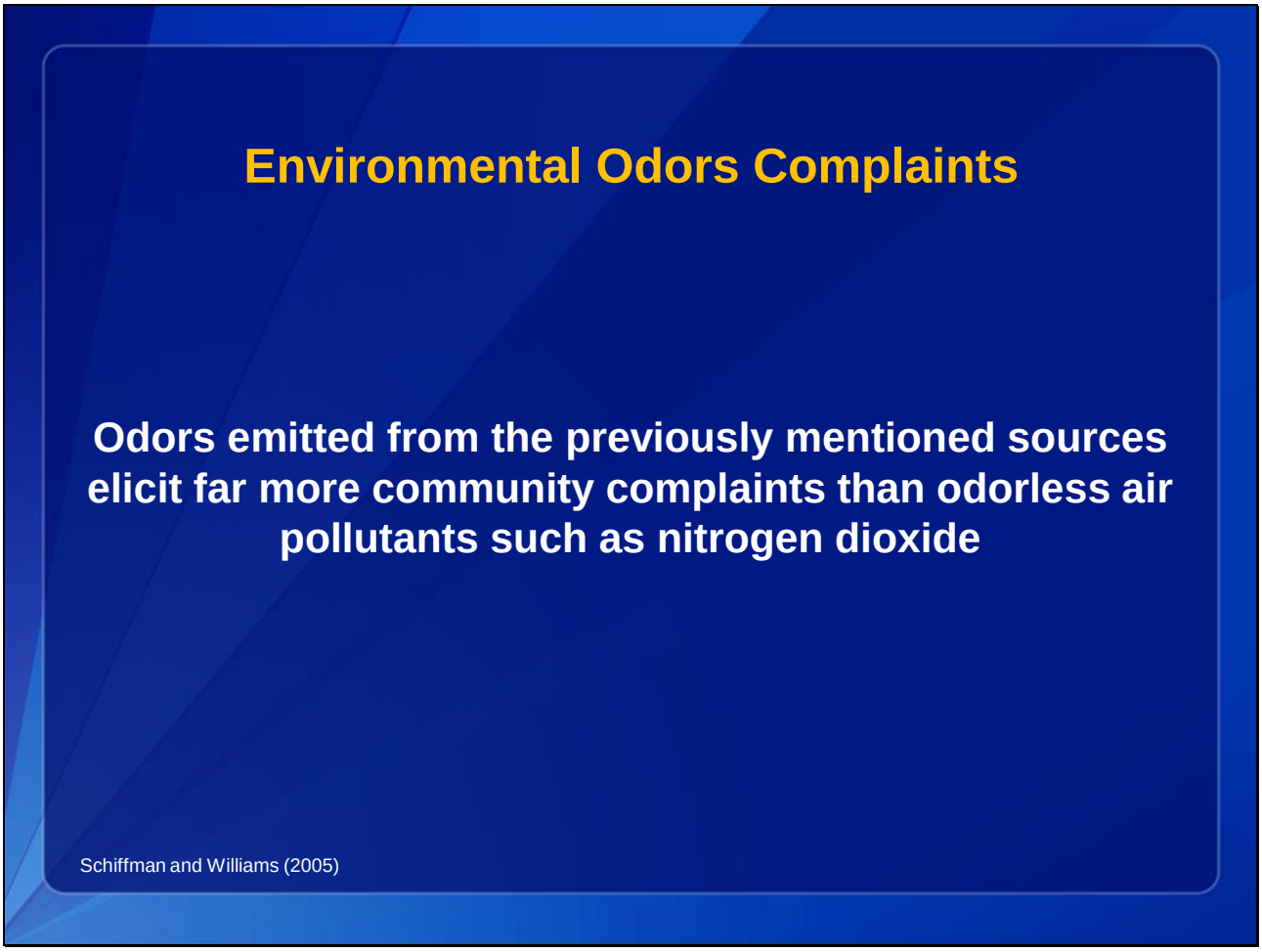
Learning Objectives

- Discuss sources of environmental odors
- Introduce brief physiology of the sense of olfaction
- Add environmental odors questions to your exposure history
- Recognize symptoms from exposure to environmental odors
- Discuss mechanism of actions for environmental odors signs and symptoms
- Learn to use the odor diary information from the community to develop health messages

Potential Sources of Environmental Odors

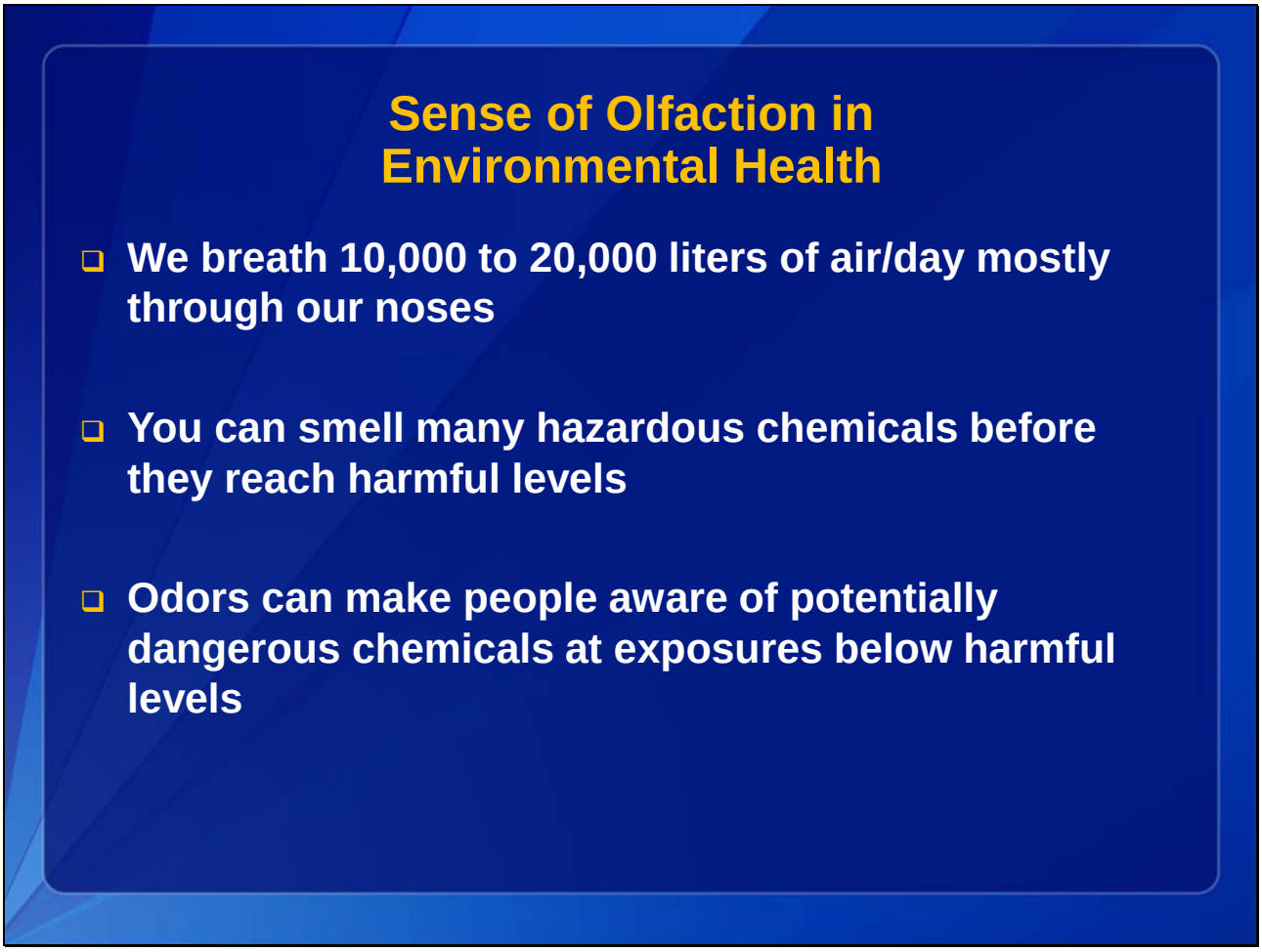
- **Animals:** Confined Animal Feeding Operations (CAFOS)
- **Human activities:** sewage, garbage, cleaning agents
- **Industry :** oil refineries, landfills, paper mills, waste water treatment plants, dry cleaners
- **Nature:** fires , gardens, moist soil
- **Vehicles:** diesel exhaust

Slide 6



Some individuals ascribe health symptoms to odor exposures, even when none would be expected based on the toxicological dose-effect relationship. Resource: Bulsing et al (2009).

Slide 7

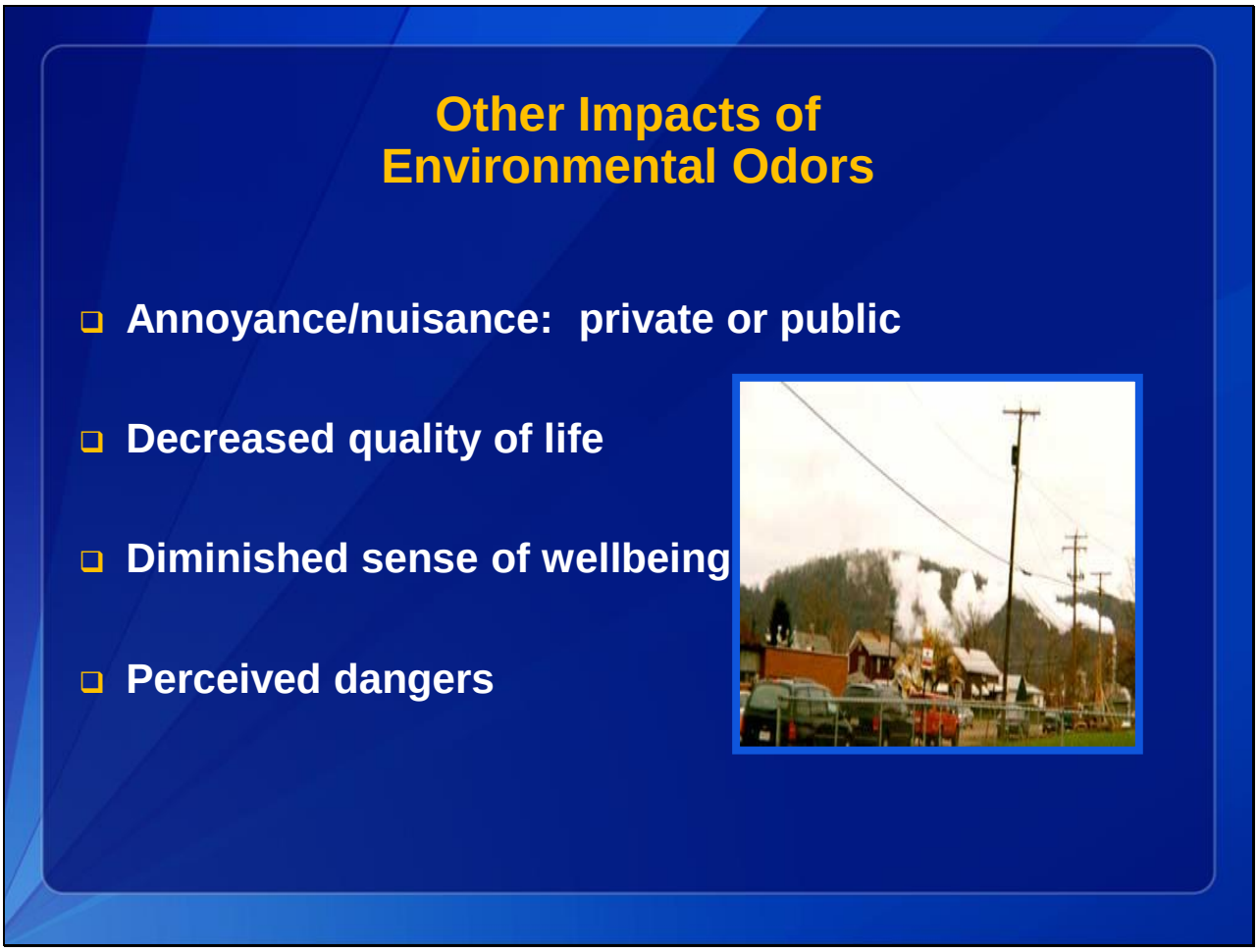


Historically, unpleasant odors have been recognized as warning signs of potential risks to human health, not direct triggers of health effects.

You can smell many hazardous chemicals before they are at harmful levels, as is the case of H_2S
H_2S **odor threshold →0.5 – 30 ppb (parts per billion or µg/kg)**
H_2S **Irritation threshold →10 – 20 ppm (parts per million or mg/kg)**
Olfactory Fatigue →100 ppm
Loss of consciousness (LOC) → 750 -1,000 ppm Knockdown or collapse (Sullivan and Krieger) paralysis of the respiratory center (Dalton 1999) and death.

Not all the ambient air concentrations of chemicals are at hazardous levels.

Slide 8



Private nuisance: Activity, situation, or conduct of another person that annoys you or inconveniences you or your family. It is also an activity, situation, or conduct that interferes with the enjoyment, health, or safety of your land, home or building.

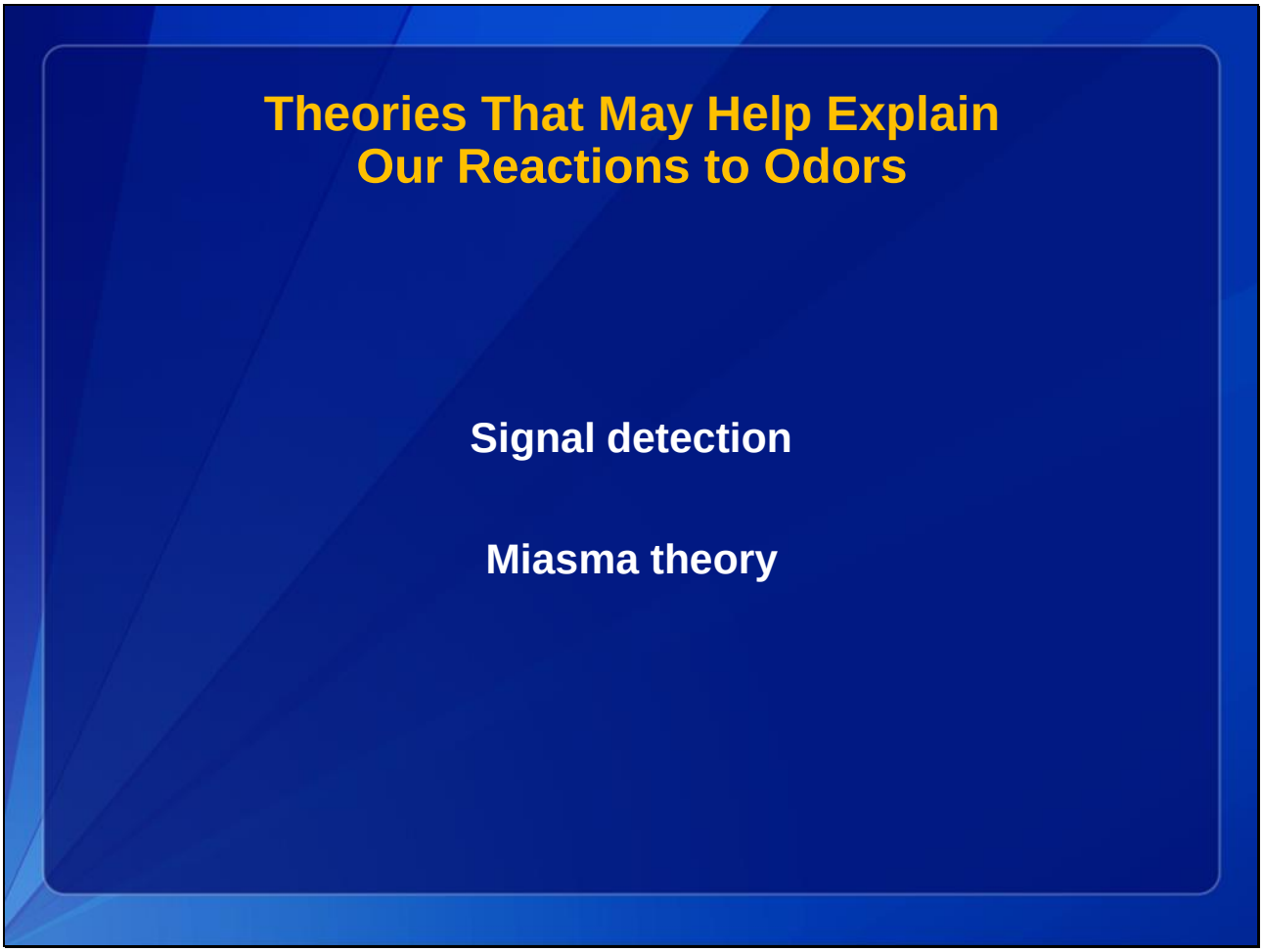
Public nuisance: Activity, situation, or conduct of another person that interferes or affects the comfort, health, or safety of the public.

Decreased quality of life: When the enjoyment of all that life has to offer is reduced.

Diminished sense of wellbeing: When the feeling that life is going well is diminished or lost.

Perceived dangers: To become aware of something through the senses. You may have the sense that something is wrong… For some people odors may be an environmental cue similar to the sound of a machine or the sign of smoke.

Slide 9



Air quality has improved over the last 50 years, yet people have become more reactive and intolerant to environmental odors.

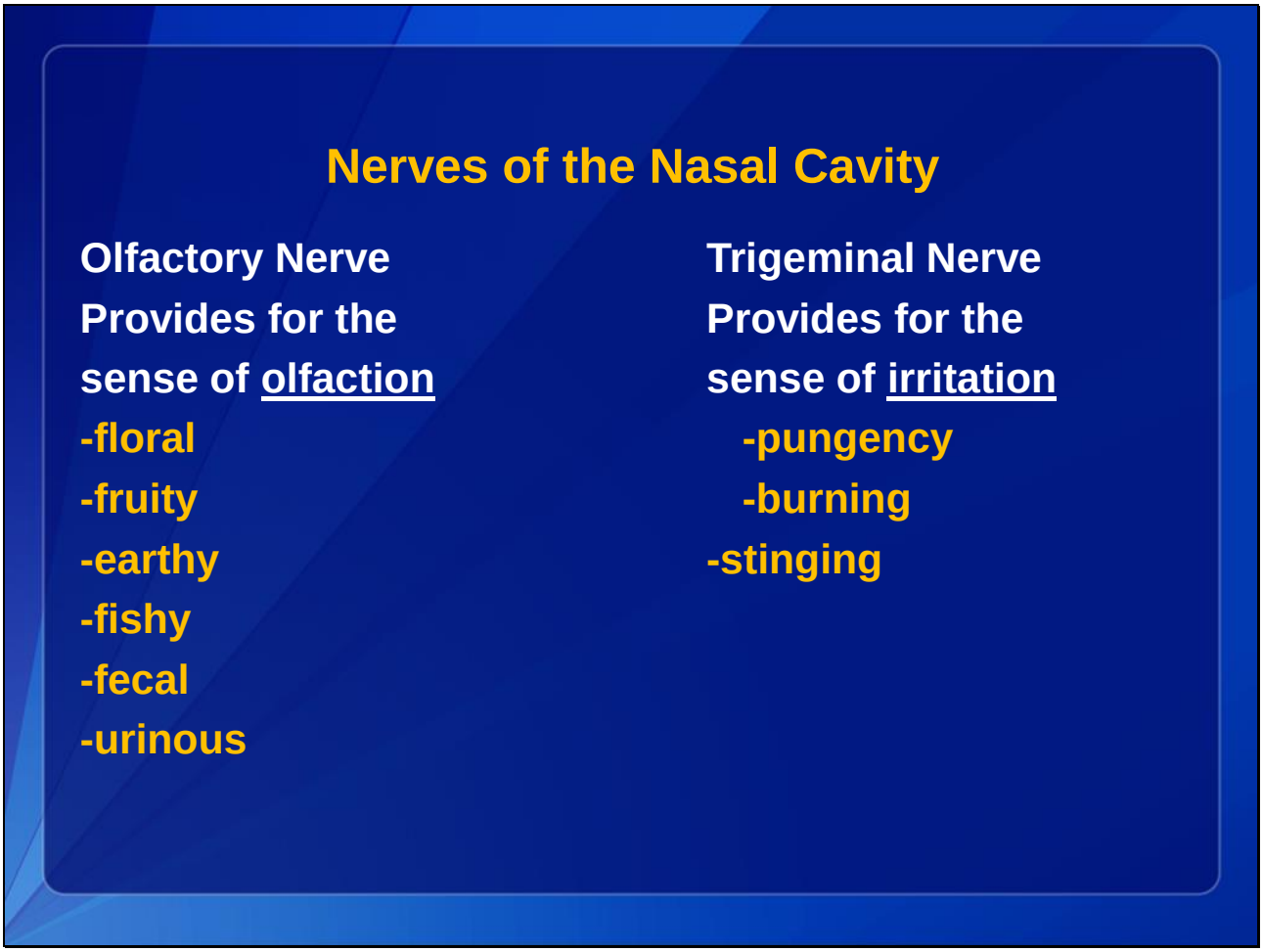
The public may not be aware that the olfactory system is able to detect extremely low levels of volatile organic chemicals, orders of magnitude lower than the threshold levels at which organic chemicals cause toxic effects in humans.

Signal Detection:
Scientists in the field of cognitive psychology believe this intolerance is due to signal detection. As the background odor becomes lower, we have become more discriminating, being able to detect even transient low levels odors. We have also become more educated or sensitized to the presence of industrial emissions with environmental odors.

Miasma Theory:
"All smell is disease"… This theory is based on beliefs of Hippocrates (460 – 377 BC) who suspected a relation between illness and places "where the air is dark and foul." The malodor he refers to was called miasma.

Until the mid-19th century, both physicians and the public adhere to the miasma theory where odors and vapors were thought to cause sickness and disease. They only smelled the odors but were not able to see the microscopic germs that actually caused the illness. Now some people think about chemical odors in a manner analogous to the miasma theory; they perceive odors and make an association with their health effects.

Slide 10



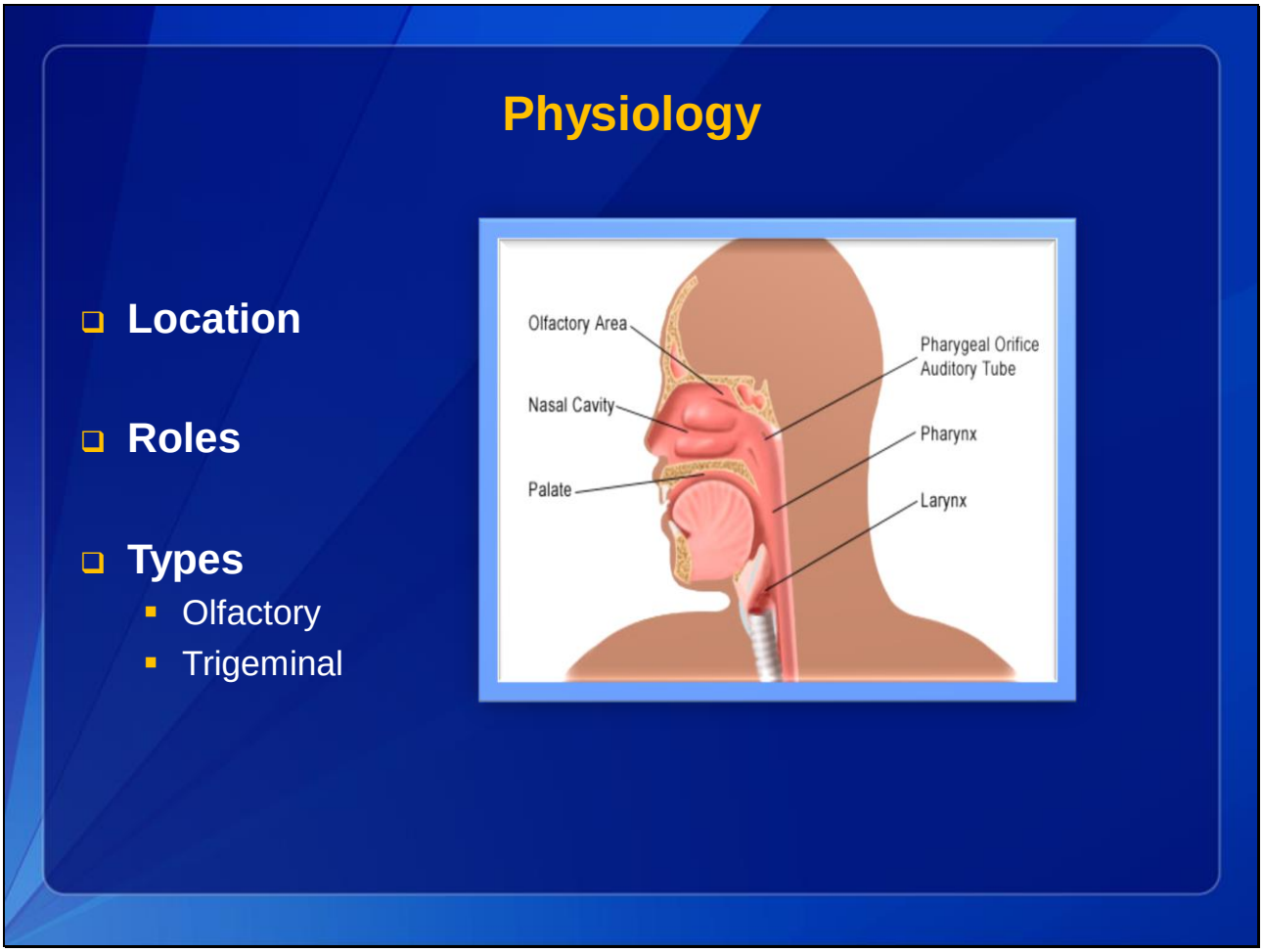
For the purpose of this presentation, we will only discuss two nerves, the Olfactory and the Trigeminal nerves. Several other nerves in the upper respiratory area provide for the sense of irritation (vagus, glosopharingeal…).

Two neurological modalities (the olfactory and the trigeminal nerves) inform us of the chemical quality of the air we breathe.

Olfactory nerve or Cranial nerve I→ provides for the sense of smell

Trigeminal nerve or Cranial nerve V→provides for the sense of irritation.

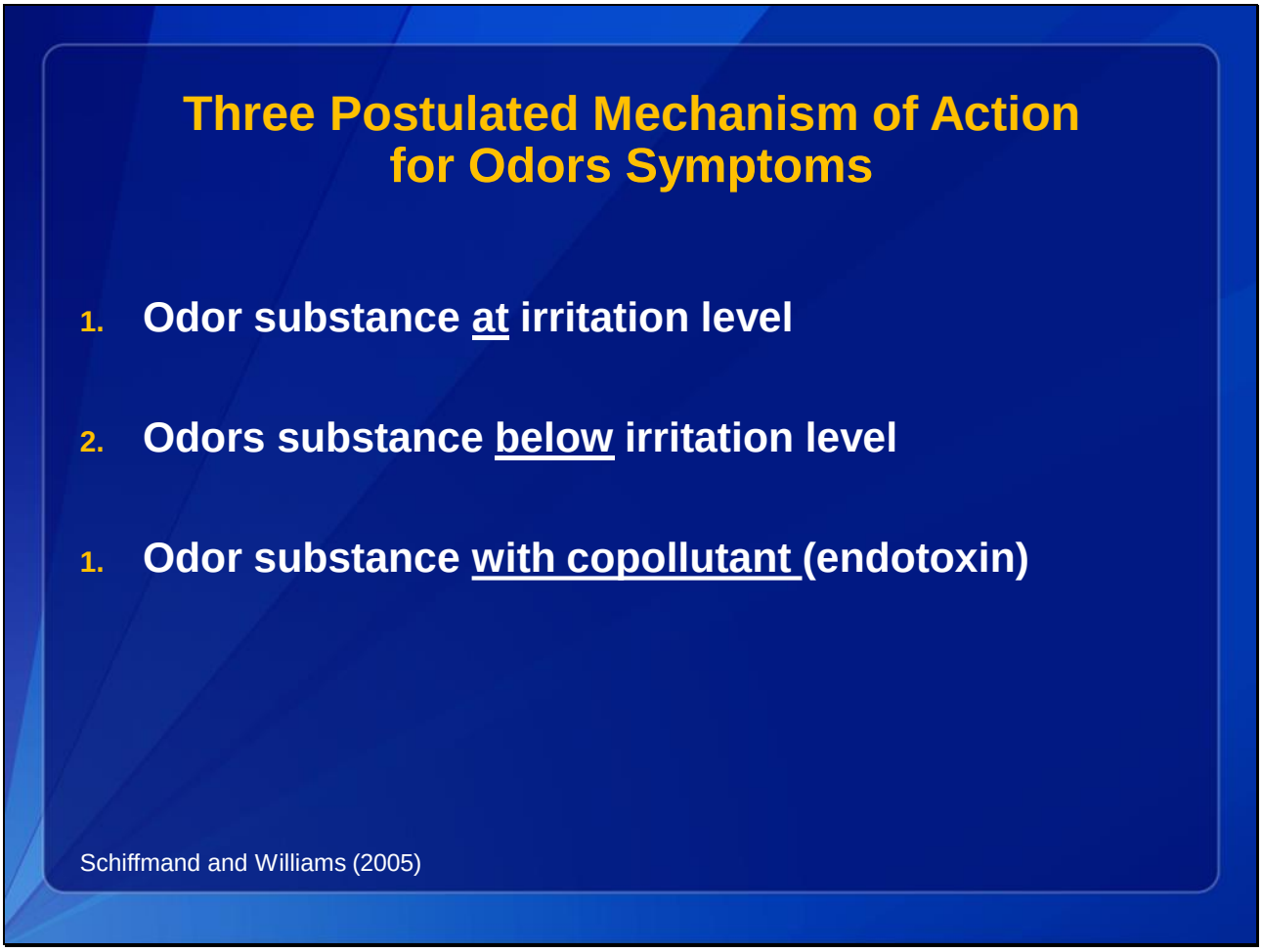
Slide 11



Odors are sensations that occur when compounds called odorants stimulate receptors in the nasal cavity.

The Olfactory Epithelium is a small patch of neurotissue located inside the noseat the top of the nostrils and at the level of the eyes. Its role is to house the odorant receptors. There are about 10,000 odoranta and only about 1,000 odorant receptors in the nose (Buck and Axel 1991). In order for humans to differentiate between the different types of odorants, each receptor is able to integrate and recognize multiple odorants. Buck and Axel discovered that receptors in the nose are like letters of the alphabet. They can be used over and over in various combinations to encode different odors, just like letters are used over and over again to spell different words. Such a system greatly reduces the number of receptors (letters) needed to code for smells (words). The way the different and overlapping combinations of letters can spell “red”, “read” or “reed,” similar combinations of receptors can identify jasmine, gardenia or lilac. According to Dr. Buck (1991) “when you alter the concentration or structure of an odorant, you also change its receptor code and, thereby, its smell.” Dr. Buck’s team also found new evidence about how the brain organizes information that the nose sends to it. The brain serves as a switching center: nerve fibers carry scent messages to both higher brain areas involved in conscious discrimination and perception of odors and to more primitive areas that mediate emotions such as fear, loathing, and pleasure.

Slide 12



Mechanism No 1

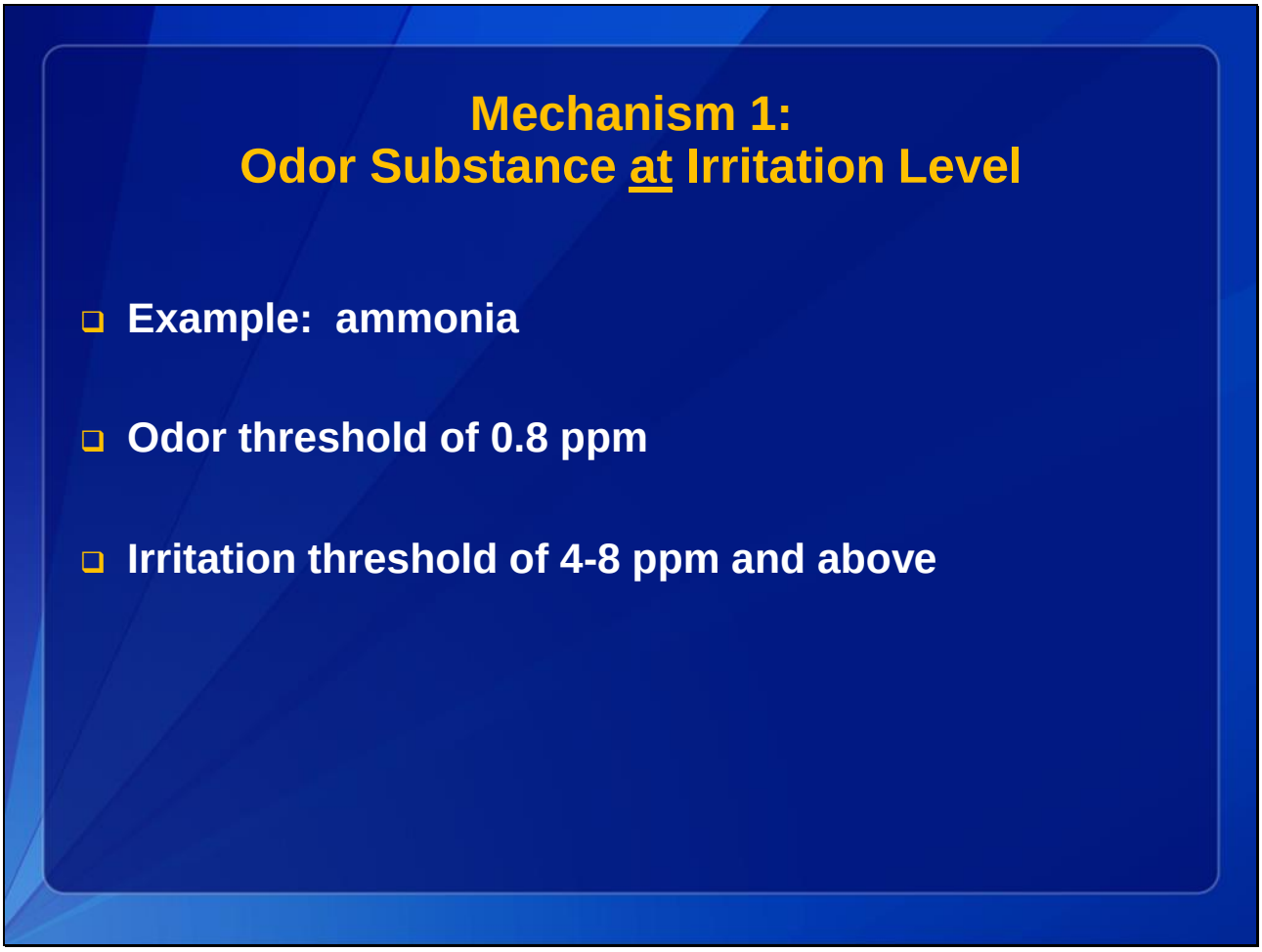
Sensory irritation induction may be caused in two ways:

- By one single odorous compound above its irritant threshold or
- By synergistic effects of several low concentration compounds also at irritation levels.

Let's think back to slide 10.

The nerve responsible for the irritation reaction to the odors is the Trigeminal nerve. Classic toxicology calls this mechanism true chemosensory irritation because it can be explained based on the dose at or above irritation level. Here "the dose is the poison" because symptoms appear when the chemical concentration is at irritation level.

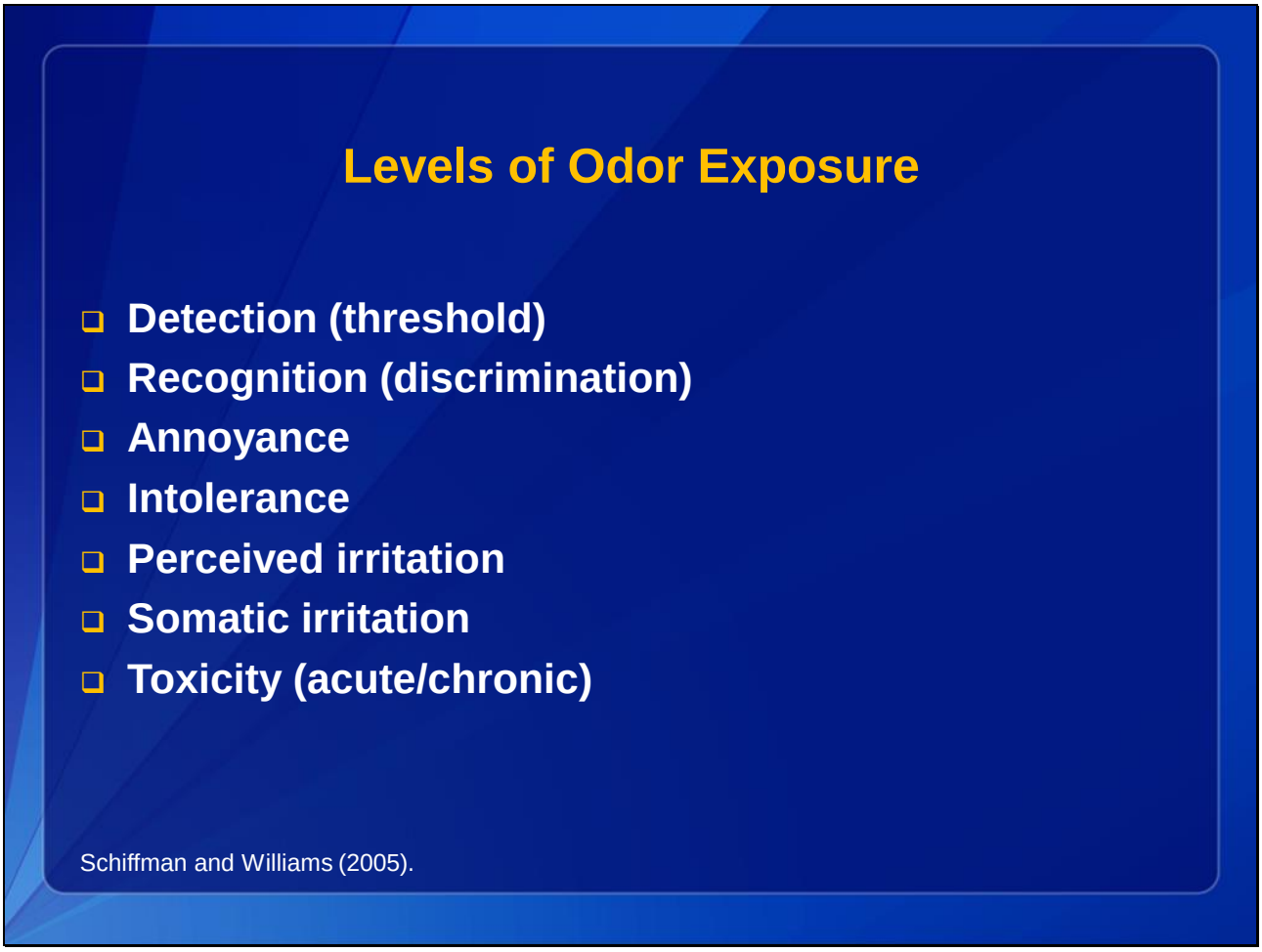
Slide 13



The irritation caused by an odorant is the problem; the odor serves only as a marker. The irritation and not the odor causes health symptoms.

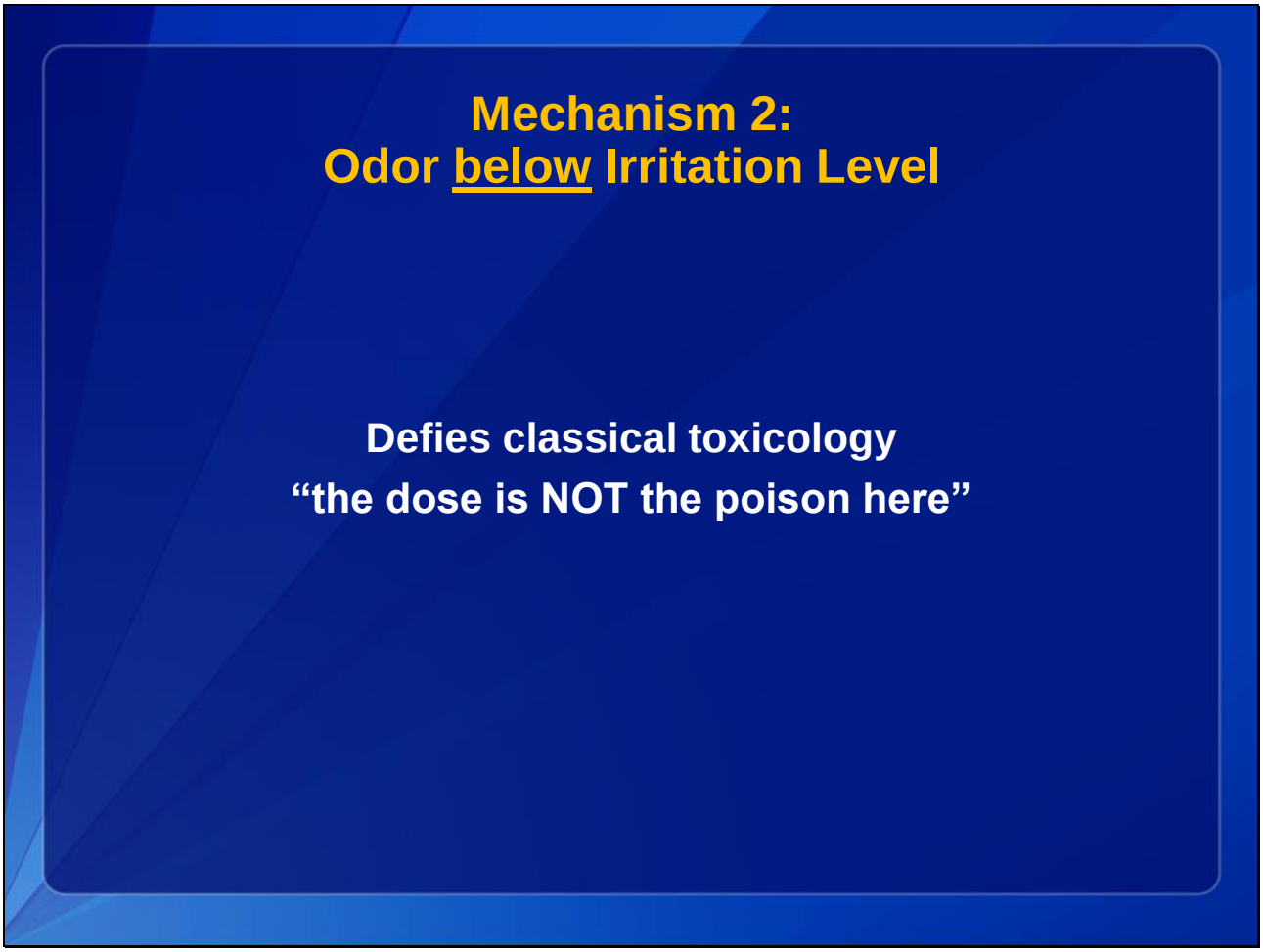
The concentration at which irritation is first detected is generally 3-10 times higher than the concentration at which an odor is first detected (odor threshold level).

Slide 14



Mechanism 1 is an example of irritation.

Slide 15

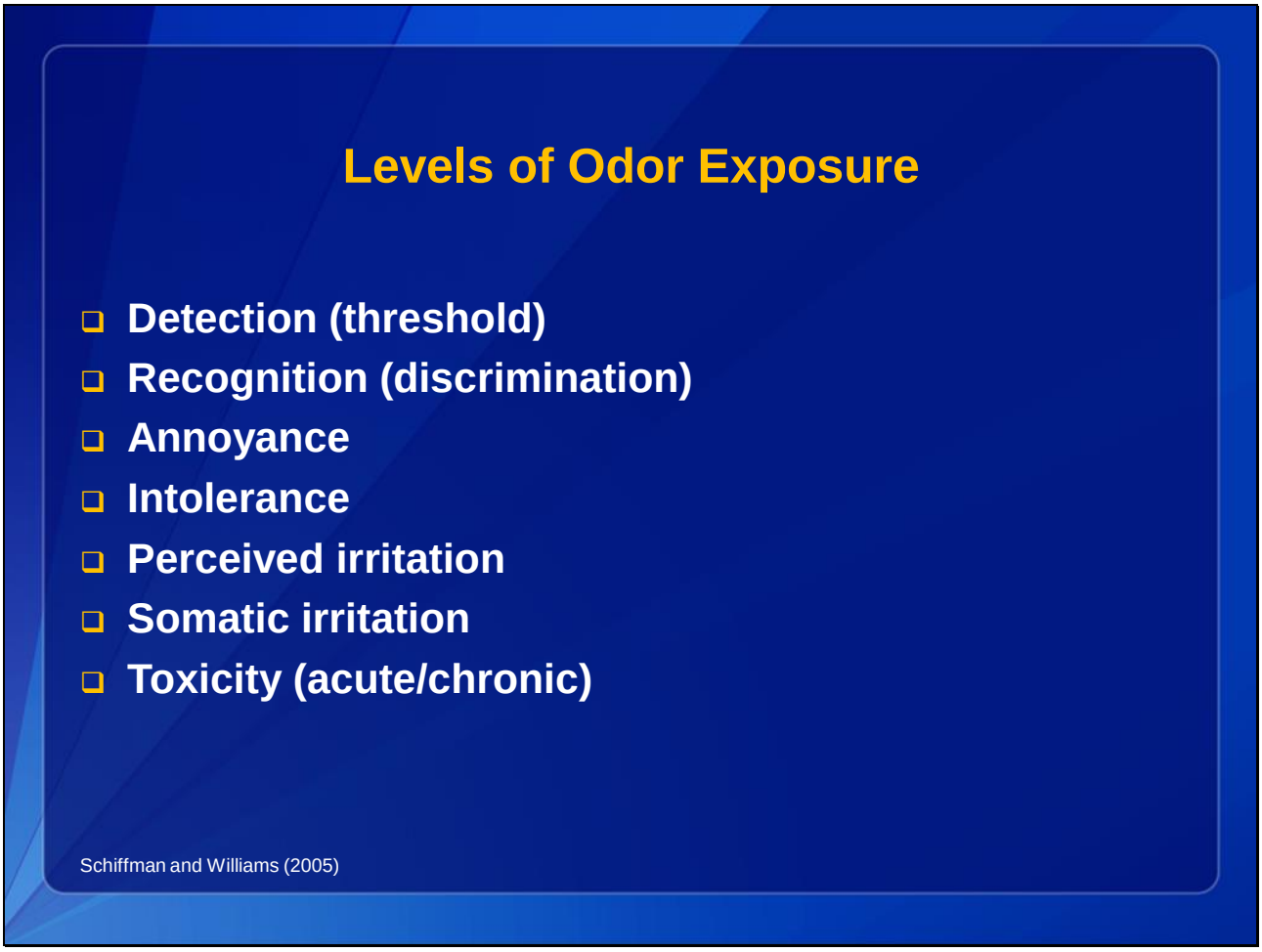


Such odor-induced health symptoms are hard to understand from a toxicological perspective: concentrations do not exceed levels where bodily effects are expected. However, there are hypotheses that help explain this mechanism.

Health complaints do occur at VOC levels below irritant thresholds.
The following may play a role in including health symptoms:
-the degree of unpleasantness of the odor,
-the exposure history (prior experience with the odor),
-beliefs about the safety of an odor, and
-emotional status.

Both genetics and learning may play a role in health complaints to unpleasant (but non-irritant odors).
In these communities, the odor-producing source may be complying with air quality standards, but if the chemical in the air is odorous, people may complain about odor-causing symptoms and…this indeed happens.
The scientific literature reports entire communities afflicted by mental depression resulting from environmental odors.

Slide 16



Mechanism 2 is an example of Annoyance.

Slide 17

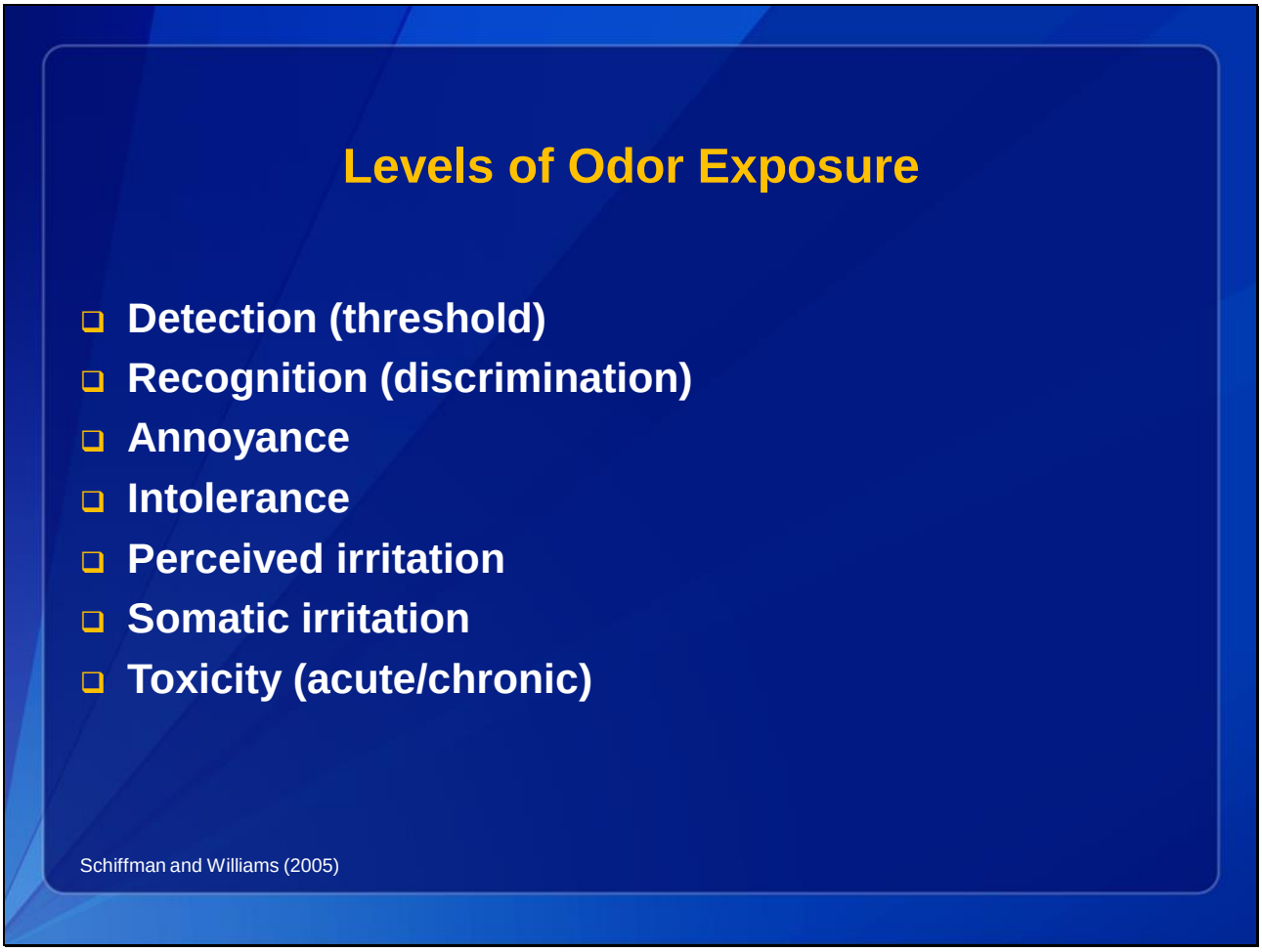
Mechanism 3:
Odor Substance with a Co-pollutant or Endotoxin

- Co-pollutant: Pesticide or bacterial endotoxin in a mixture of odors is responsible for health effects
- Health effect not expected unless mixed with a co-pollutant

Schiffman and Williams (2005)

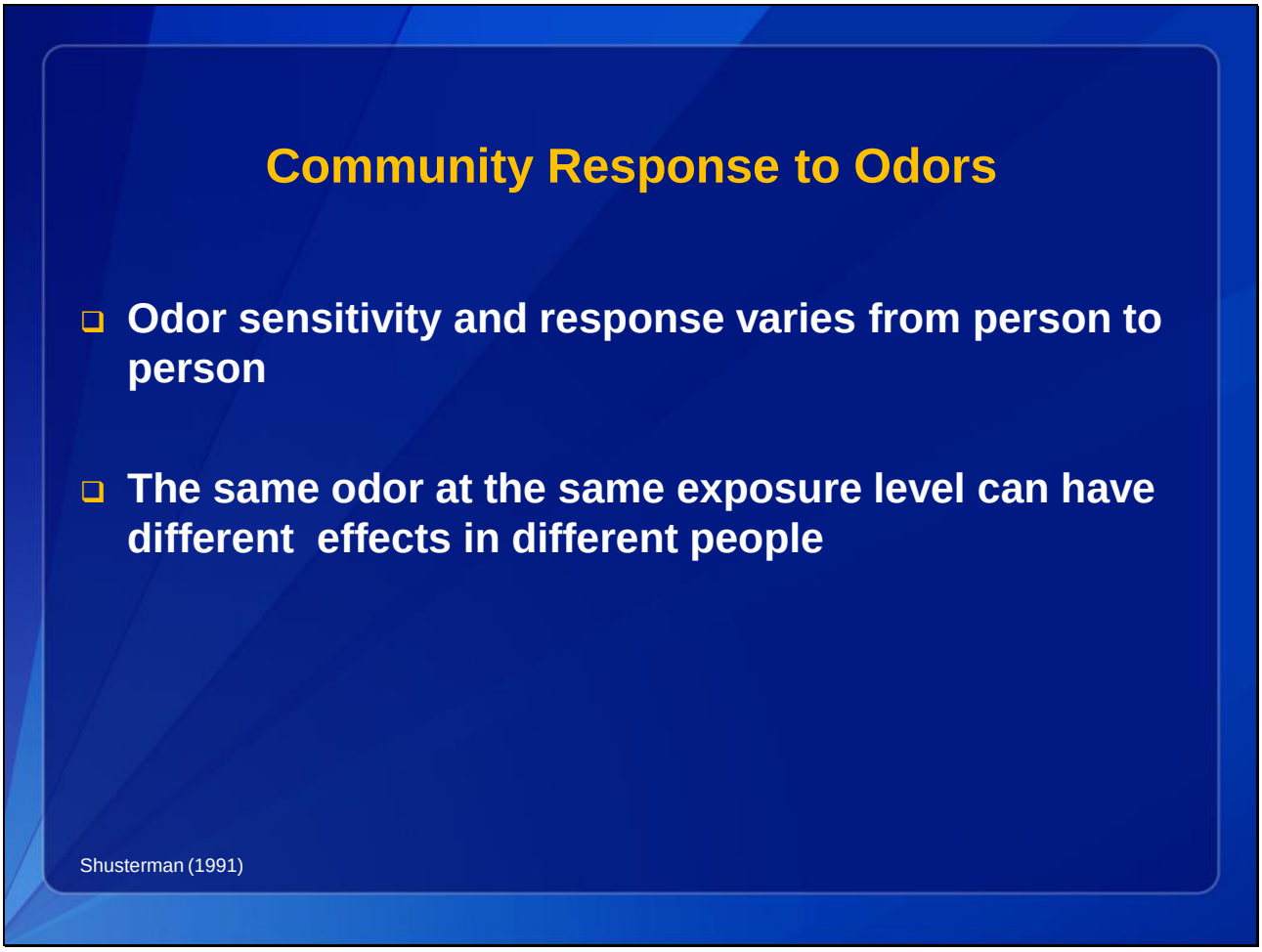
Mechanism 3 is an example of toxicity

Slide 18



Mechanism 3 is an example of toxicity

Slide 19



<u>One thing has been studied and reported:</u>
Odor worry appears to be a *synergistic* determinant of symptom reporting.

<u>This gave rise to an explanatory model where</u>

- Odors may act as a marker for toxicologically significant exposure
- Odors may precipitate symptoms in their own right
- Odors serve as a cue for stress-related symptoms among individuals who perceive the odor source as posing a toxicological risk

Slide 20

Community Response to Odors (cont…)

Individual responses may vary by

- **Age**
- **Genetics**
- **Gender**
- **Medical history (mental depression)**
- **Life style**
- **Social habits**

Dalton (1999) Shusterman (2001)

Age: Both extremes are at increased risk
Genetics: innate aversion
Gender: women tend to be more susceptible to become symptomatic from odors
Medical history: people suffering from mental depression and other medical conditions: asthma, COPD, chronic sinusitis, headaches, migraines, seizures, tachycardia.
Lifestyle: outdoor exercise
Social habits: tobacco, environmental tobacco smoke, alcohol abuse.

Slide 21

Community Response to Odors (cont…)

- **Subjective symptoms –not measurable**
  - Person feels it/examiner cannot see it
    - Nausea
    - Headache…
- **Objective symptoms –measurable**
  - Person complains about it/examiner can see it and/or hear it
    - Redness and/or tearing of the eye
    - Wheezing

Identifying these differences can prompt the clinician to do a more careful investigation of other factors such as emotional that may be responsible for the sensory response.

Slide 22

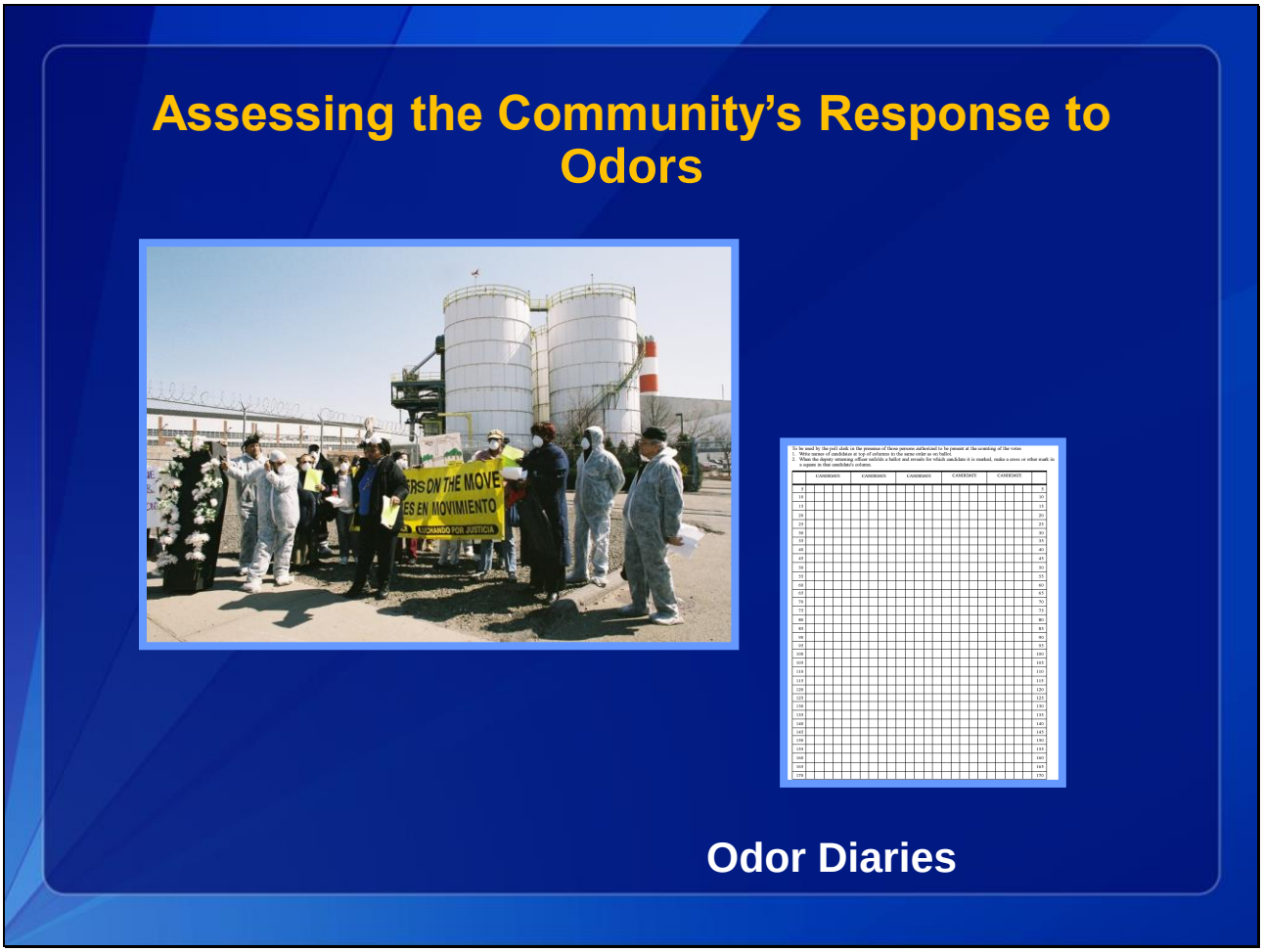
Community Response to Odors (cont…)

Sensitive populations; people with

- **Asthma**
- **Chronic obstructive pulmonary disease (COPD)/emphysema**
- **Depression**

An environmental odor may NOT be harmful at the concentration perceived by a person, but it may affect people with asthma, thus exacerbating an attack. The signs and symptoms usually subside after the exposure ends.

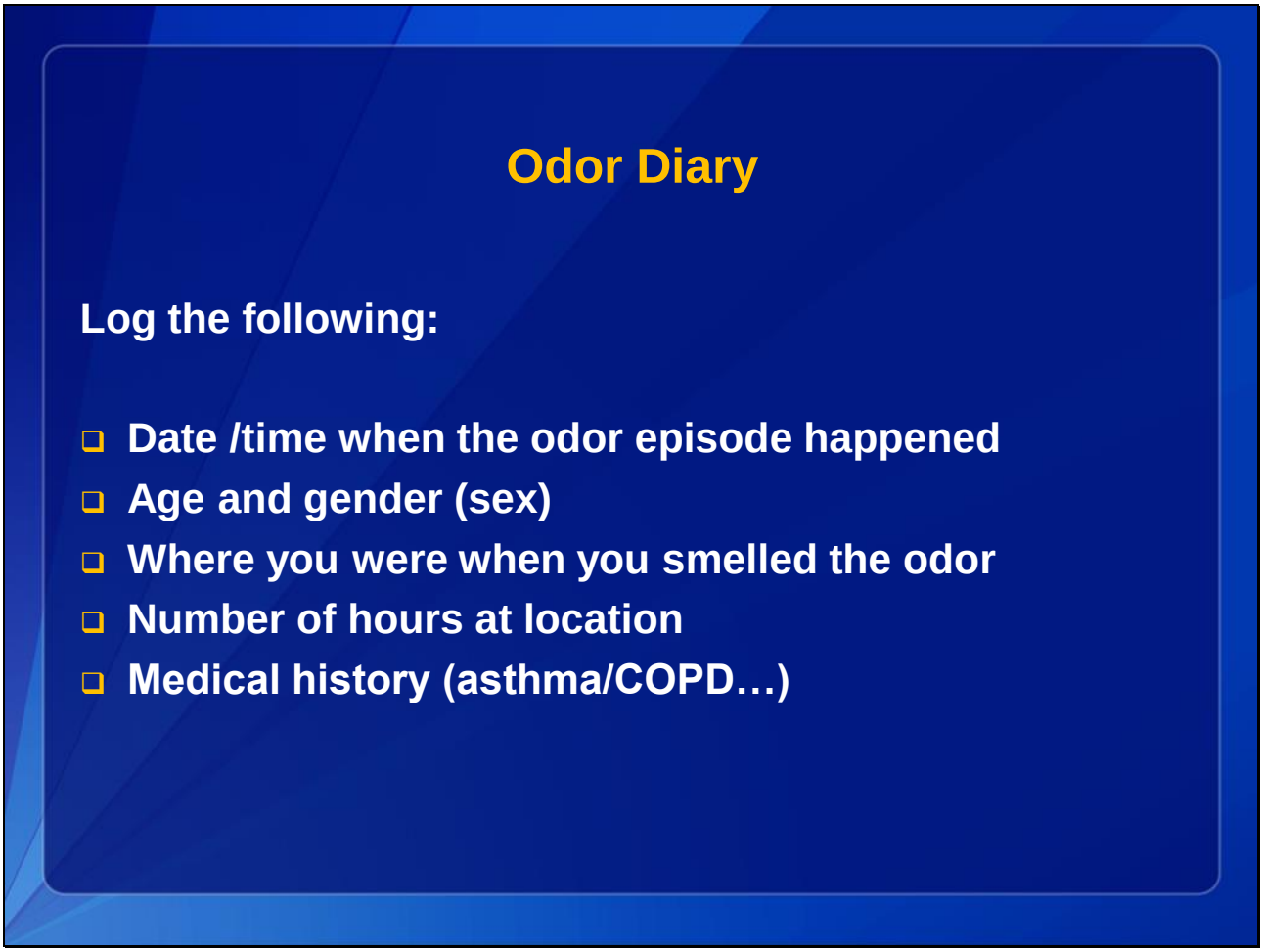
Slide 23



Assessing the community's response to odors is helpful for making recommendations and developing health messages. An odor diary is one way to assess responses to odors and can be implemented by the community or by environmental or health agencies.

An odor diary can be part of an exposure investigation.

Slide 24



An odor diary is a tool for community assessment of odor response
An odor diary –implemented by community members- can help them discerns things like odor types and times of day when odors are worse.

Including questions on age, sex and certain medical conditions can help identify risks factors

Be sure to include the hours at the location each day.

Diaries are easy to fill out and easy to tabulate, use them for no more than 2 weeks.
Fill them out every day during those 2 weeks, even when there is no odor.

Slide 25

Odor Diary (cont…)

Log the following:

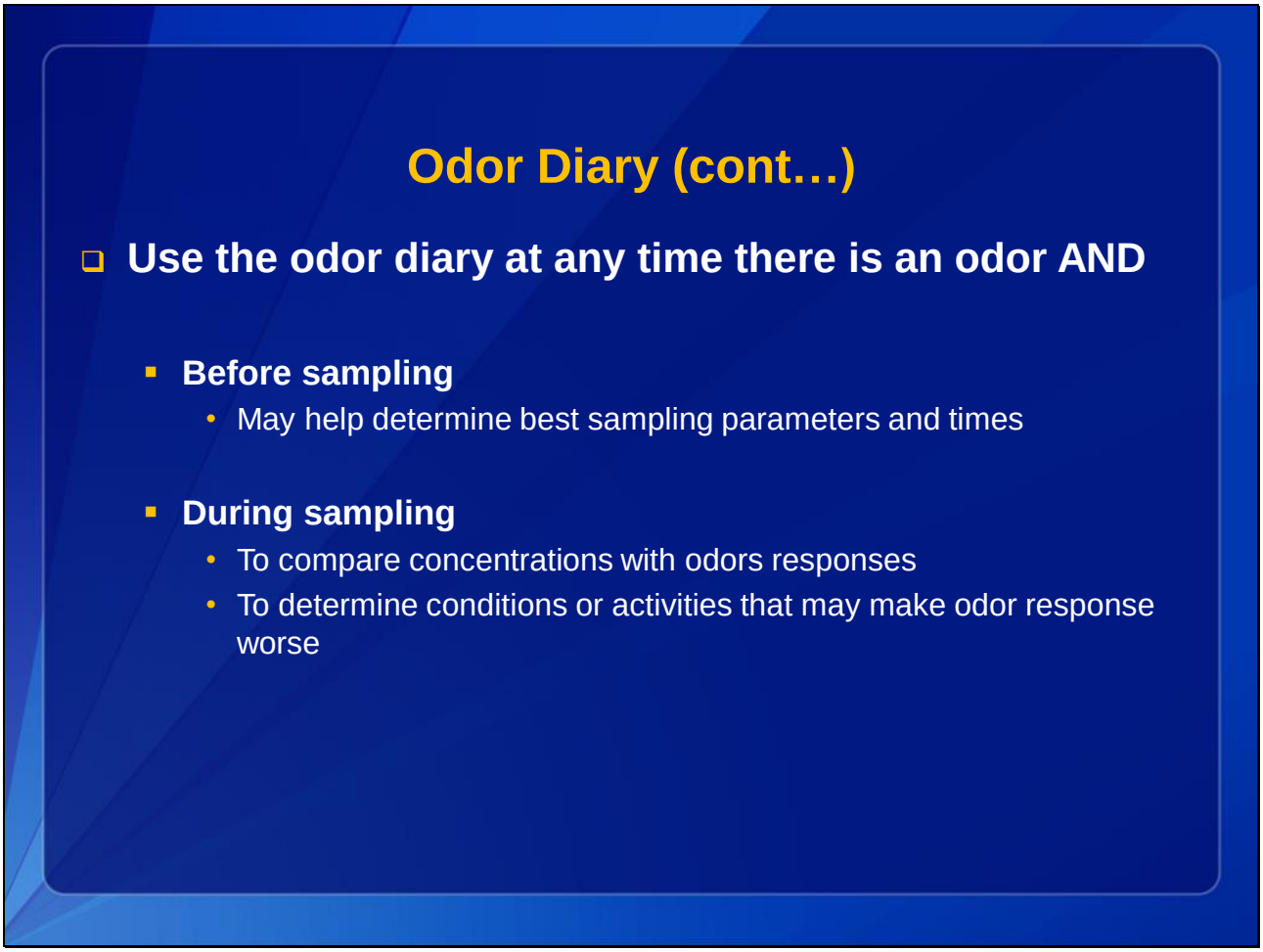
- **Description of the odor and duration of exposure**
- **Season and time of the day or night**
- **Outdoor activities (gardening, exercise school sports, etc.**
- **Outdoor conditions (calm, windy, raining etc.)**

Try to limit the number of questions in favor of compliance.

<u>Note the following each day:</u>

- Description of odor and duration
- Activities done (e.g., amount of outdoor exercise)
- Time of day and season
- Outdoor conditions (e.g., calm, windy, raining, etc.)

Slide 26



Before sampling:
If an odor diary is used before air sampling, the results may provide information on the type of odor and when it is more prevalent. People can use this information to determine what chemicals to include in a sampling plan and the best times to sample.

During sampling:
Collecting odor information during sampling can assist with comparing the recorded concentrations with the odor responses. The condition and activities information may provide information on what makes the odor response worse.

Slide 27

Odor Diary (cont…)

- **Drawbacks**
  - Self reported –may not be able to act on information collected
  - May create stress
  - OMB approval may be needed

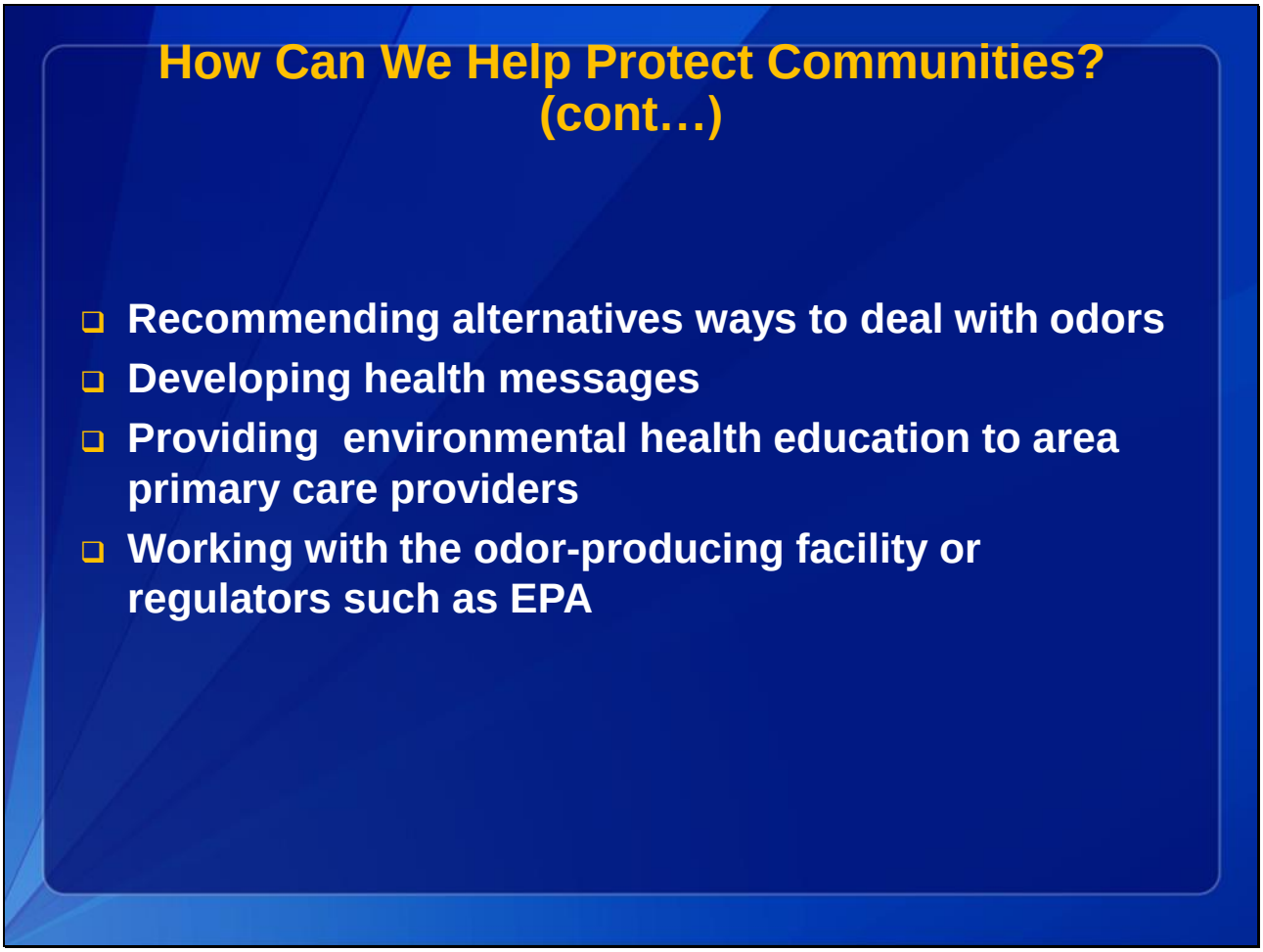
http://www.archives.gov/federal-register/laws/paperwork-reduction/

Because they are self-reported, odor diaries may introduce bias. Sometimes agencies choose not to use the information collected.

Odor diaries are qualitative descriptions of an event; they are not scientific research. People may spend lots of time and effort on the diaries and no action may be taken.

Even when odor is not present, anticipation of odor may create stress. Also recording the events may make people hyper vigilant, thus creating more stress.

Slide 28



Environmental and health agencies can help by making recommendations, providing education, providing suggestions to the odor-producing facility or regulators and developing health messages.
The results of air sampling /monitoring and odor diary can assist with tailoring the recommendations and messages.

Communities can also help protect themselves by reviewing the answers to the odor diaries to determine personal actions they can take to cope with the odors and to develop suggestions for facilities and regulators.

Let’s explore these solutions one by one.

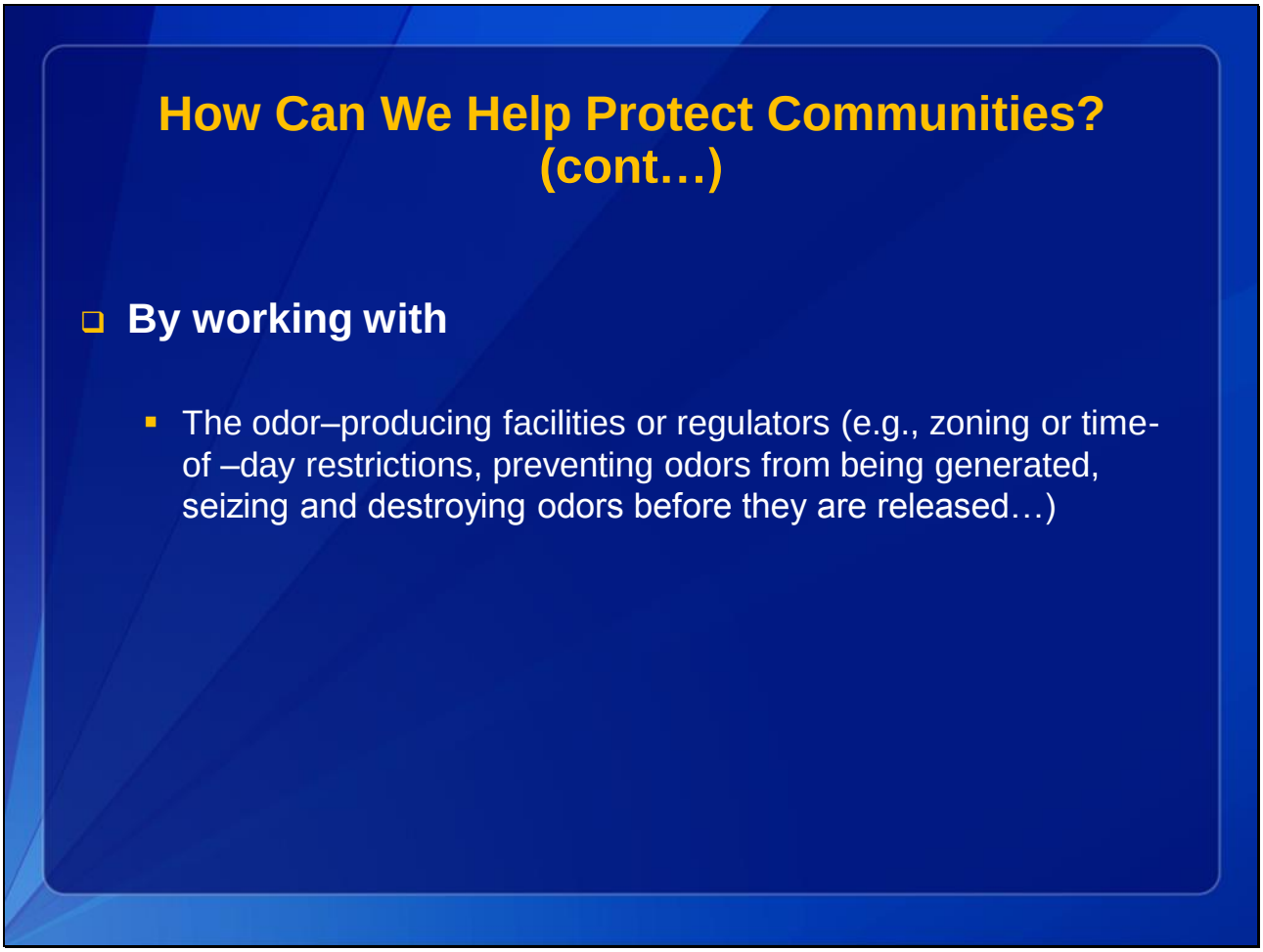
How Can We Help Protect Communities? (cont…)

- **By recommending**
  - Personal actions to reduce exposure (for example, exercise indoors, close windows, leave the area for a while if able)

How Can We Help Protect Communities? (cont…)

- **By providing**
  - Environmental health education for area primary care providers ,
    - Examples include Environmental Health Grand Rounds presentations in area hospitals, facts sheets, flyers

Slide 31



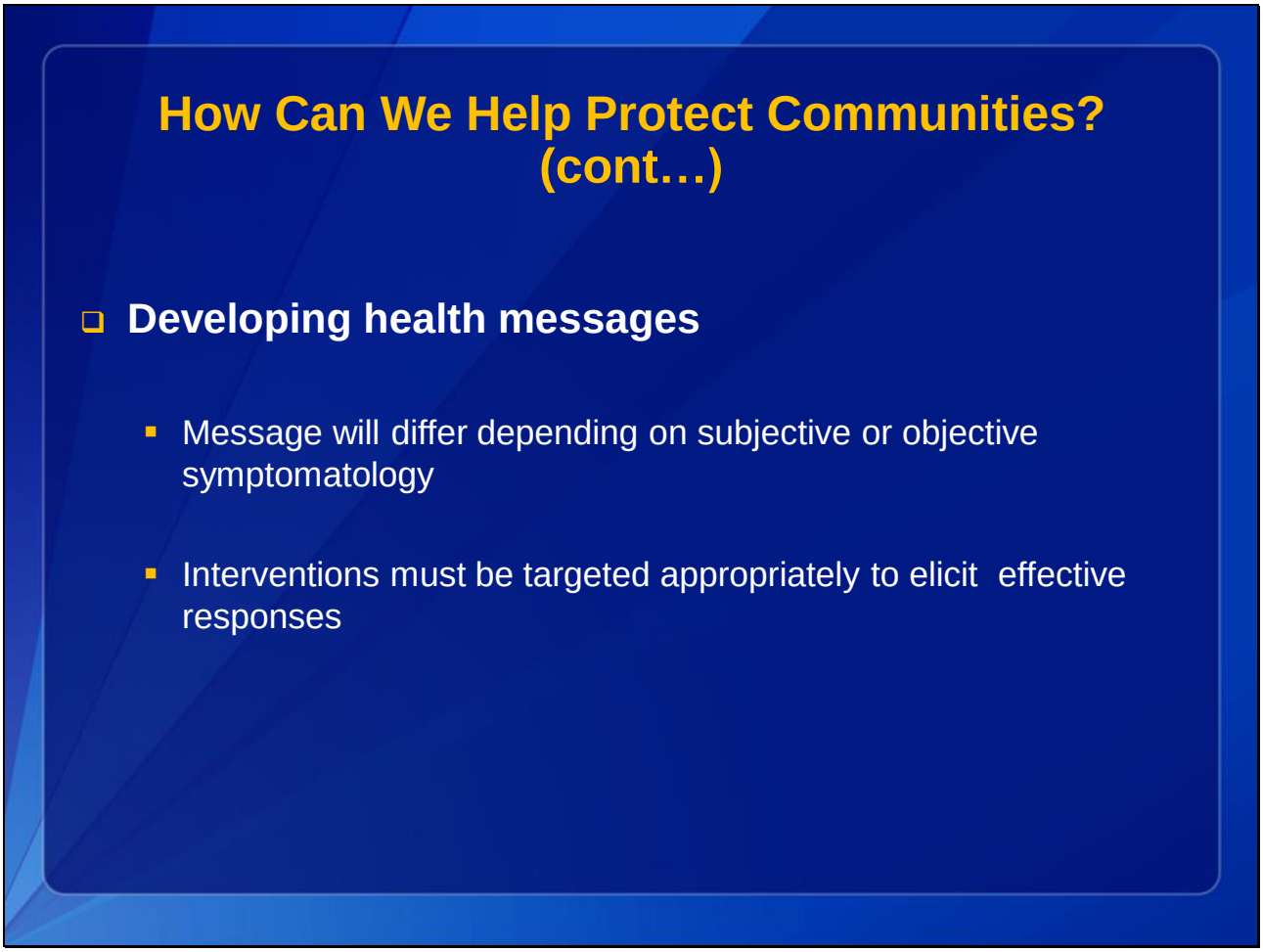
Additionally, the community or environmental and health agencies can discuss the findings of the odor diaries with the odor-generating facility and/or local legislators /regulators and suggest alternatives when odors are worse.

Alternatives can include
-Operational time of day restrictions
-Zoning restrictions, and
-Suggestions on ways to reduce emissions (e.g., planting trees, using control technologies).

The above are tools for reducing odor through local implementation of legislation or good–neighbor relationship.

Prevention is number one, and we know there are technologies for mitigating odors that help decrease the health effects of environmental odors.

Slide 32



One good reason to know the difference between subjective and objective symptomatology is to be able to aim the interventions appropriately to elicit effective responses.

Anxiety over the consequences of exposures and other environmental stressors can augment the subjective symptoms.

If the level of the substance is below irritation levels, then reducing the exposure level of the chemicals may have no beneficial effects as long as the odor is still detectable.

Direct Quote:

"…Odorous commercial facilities should reduce or eliminate odorous air pollution that evokes health complaints and impairs quality of life in neighboring communities…" Schiffman and Williams (2005).

Odor Control Technology

- Preventing odors from being generated
- Capturing and destroying odors before they are released into the environment
- Dispersing or concealing odors to avoid nuisance when transporting away from the odor source
- Zoning restrictions
- Restricting times of days
- Planting trees

Sheffield and Bottcher.

Conclusion

- Tools such as odor diaries have a role in
  - Assessing the community response to odors
  - Making recommendations and
  - Developing health messages

Conclusion (cont…)

- Historically unpleasant odors were recognized as warning signs of potential risks to human health
- We now know that odors from environmental sources might cause health symptoms depending on individual and environmental factors

Schiffman and Williams (2005)

“Odors in public health practice are not only warnings signs of potential health effects, but may in itself be the direct cause of some symptoms in humans.”

Schiffman and Williams (2005)

References

1. Baldwin et al. 2004
2. Buck and Axel. 1991
3. Bulsing et al. 2009
4. Dalton. 1999
5. Dalton 2003
6. Dalton 2003
7. Knutson 2003
8. Rosen Kranz 2003
9. Schiffman and Williams 2005
10. Shusterman. 2001

References (cont…)

11. Van Thriel 2008
12. Sullivan and Kneges
13. Sheffield and Botteher
14. Wing et al. 2008

Slide 39

Slide 40

For more information, please contact Agency for Toxic Substances and Disease Registry

4770 Buford Hwy, NE Chamblee, GA 30341

Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348

Visit: www.atsdr.cdc.gov | Contact CDC at: 1-800-CDC-INFO or www.cdc.gov/info

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Division of Community Health Investigations (DCHI)

ATSDR