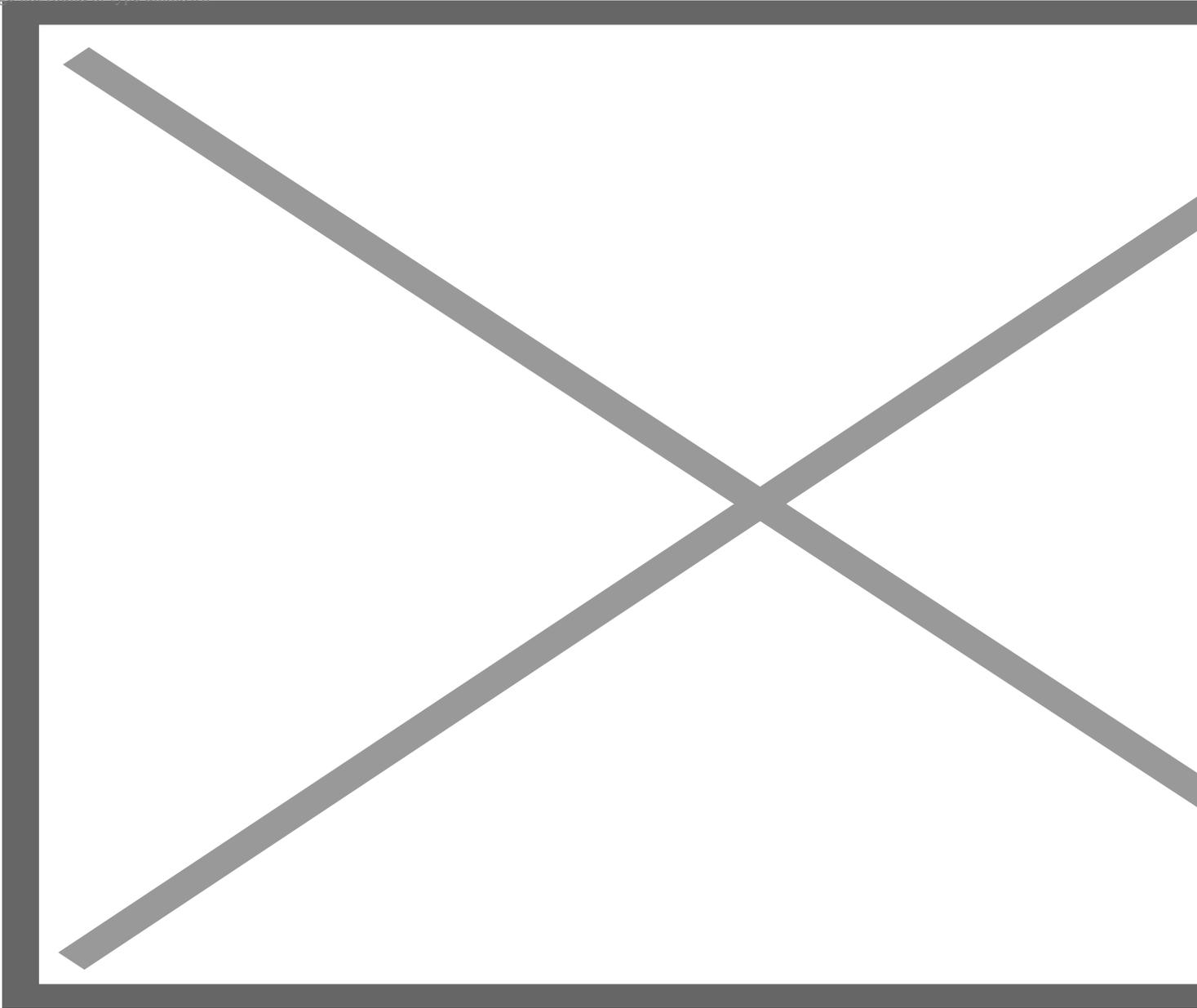


The science of critical thinking

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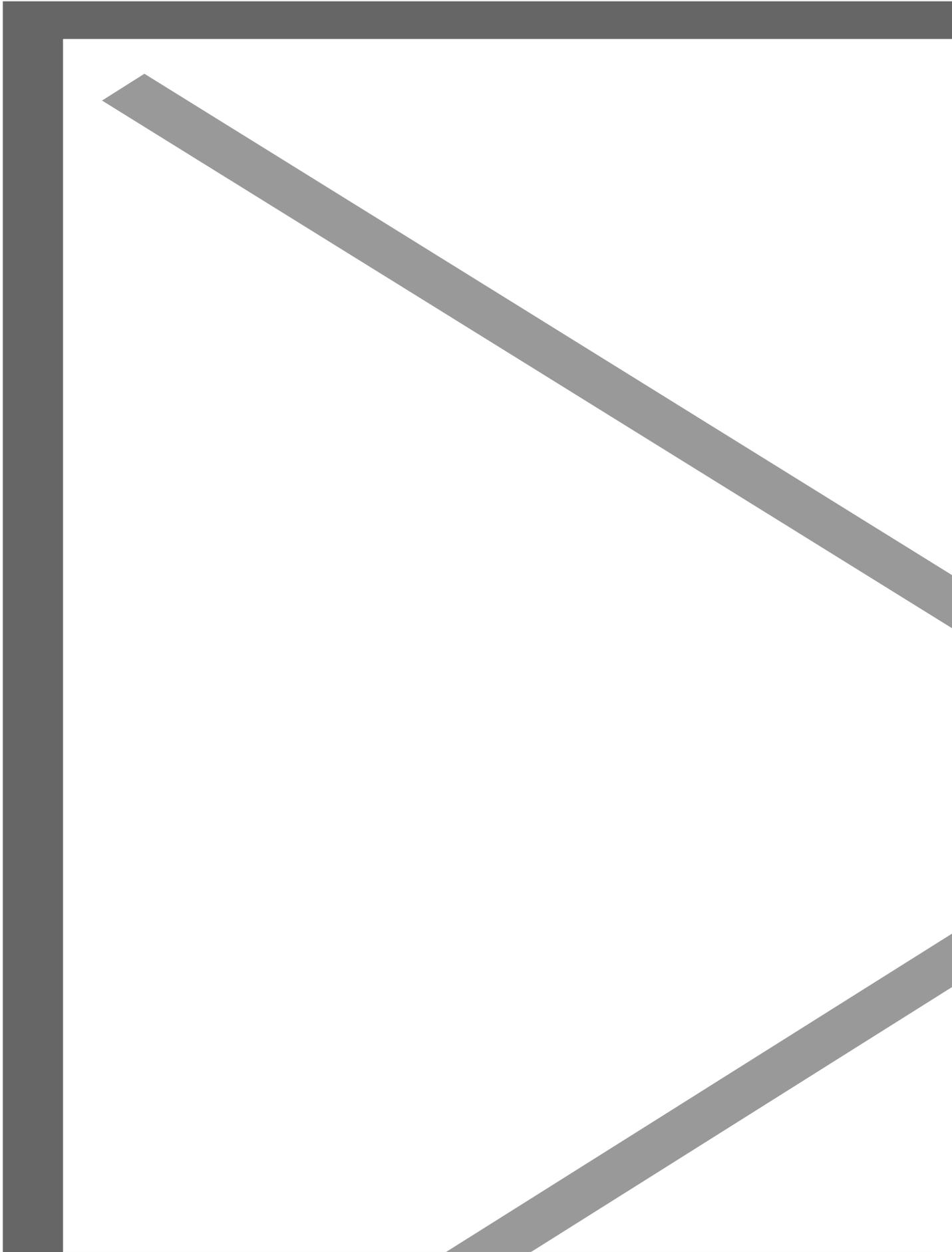
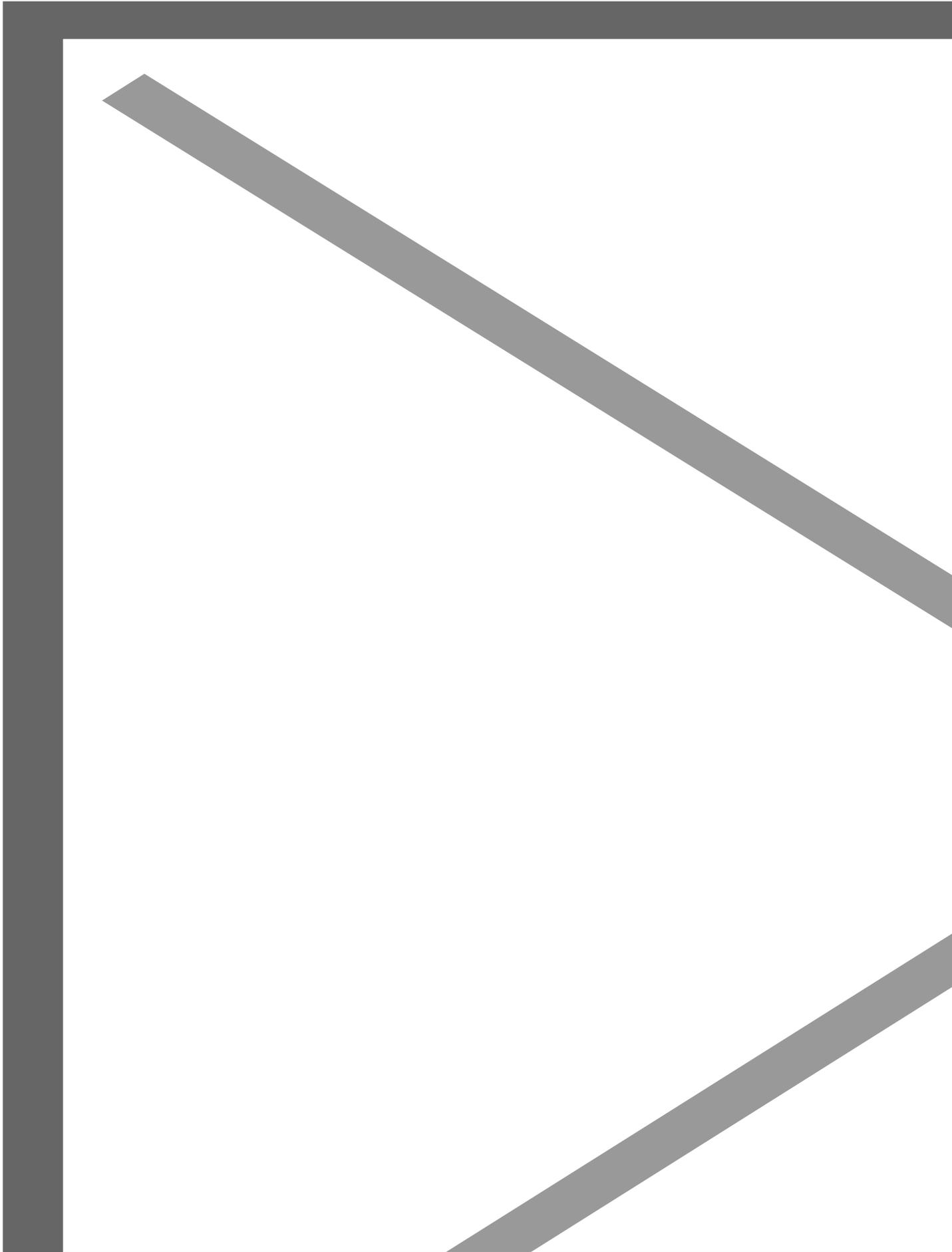


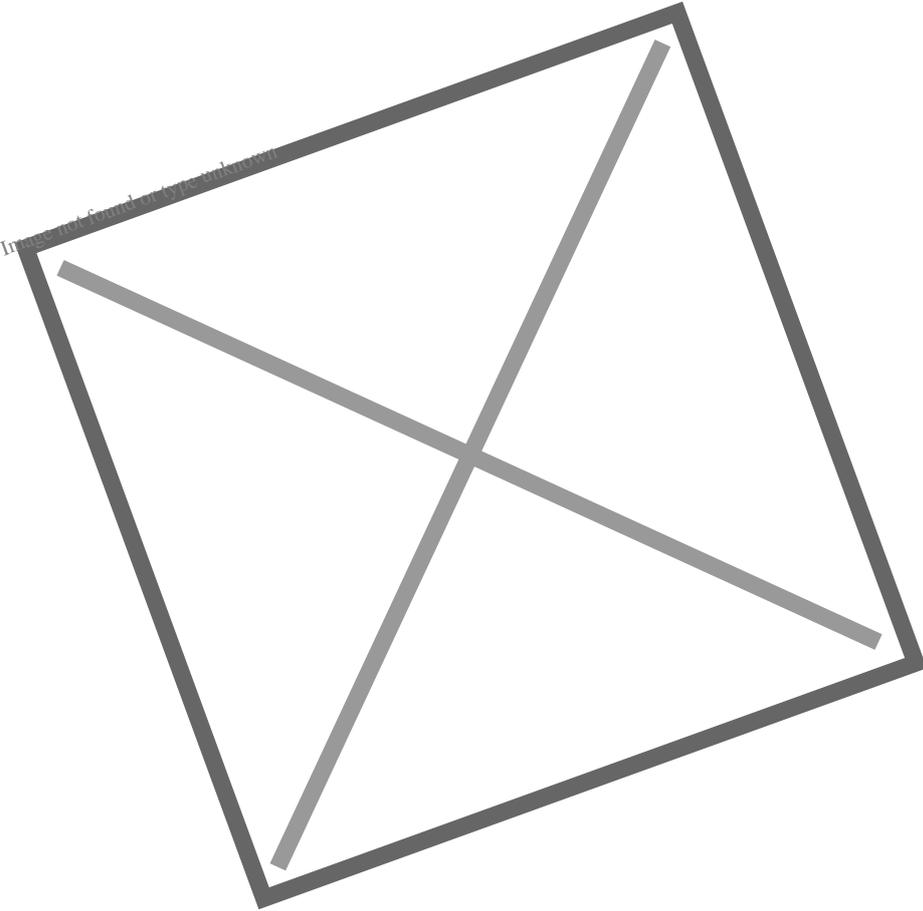
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"People demand freedom of speech as a compensation for the freedom of thought which they seldom use."

? Søren Kierkegaard

www.Cognitive-Liberty.online



"Disobedience is the true foundation of liberty. The obedient must be slaves." ~Henry David Thoreau

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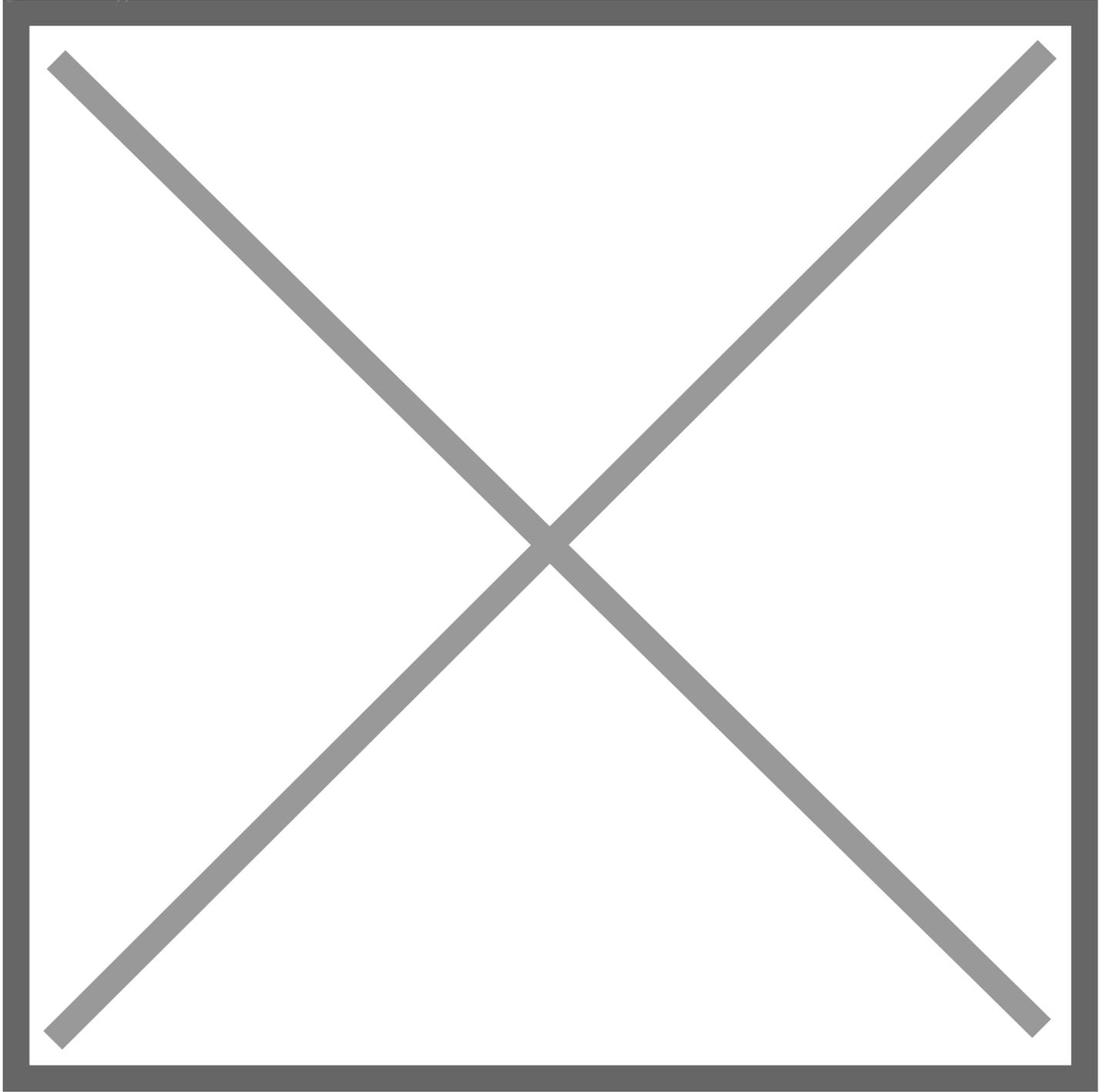
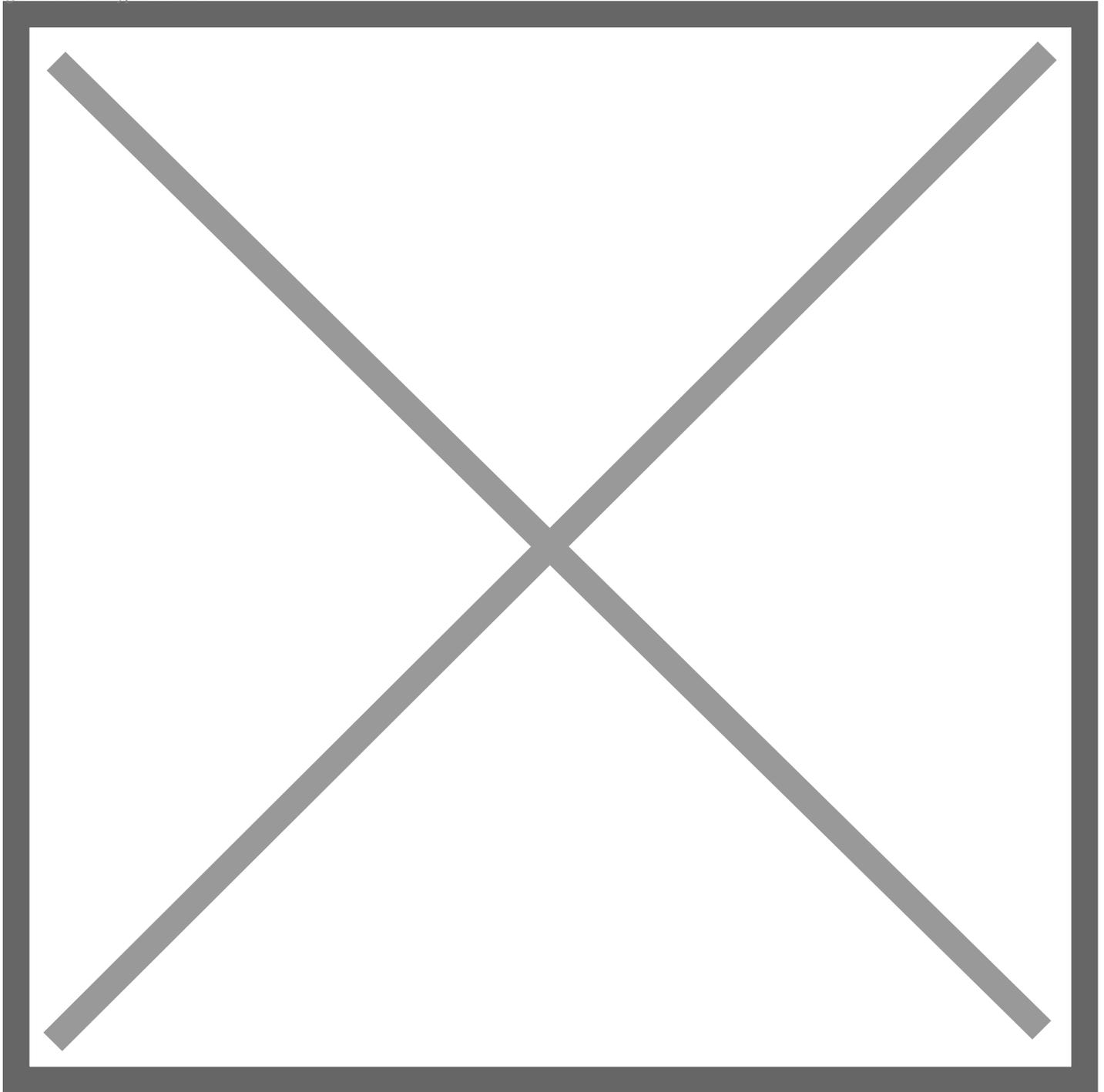
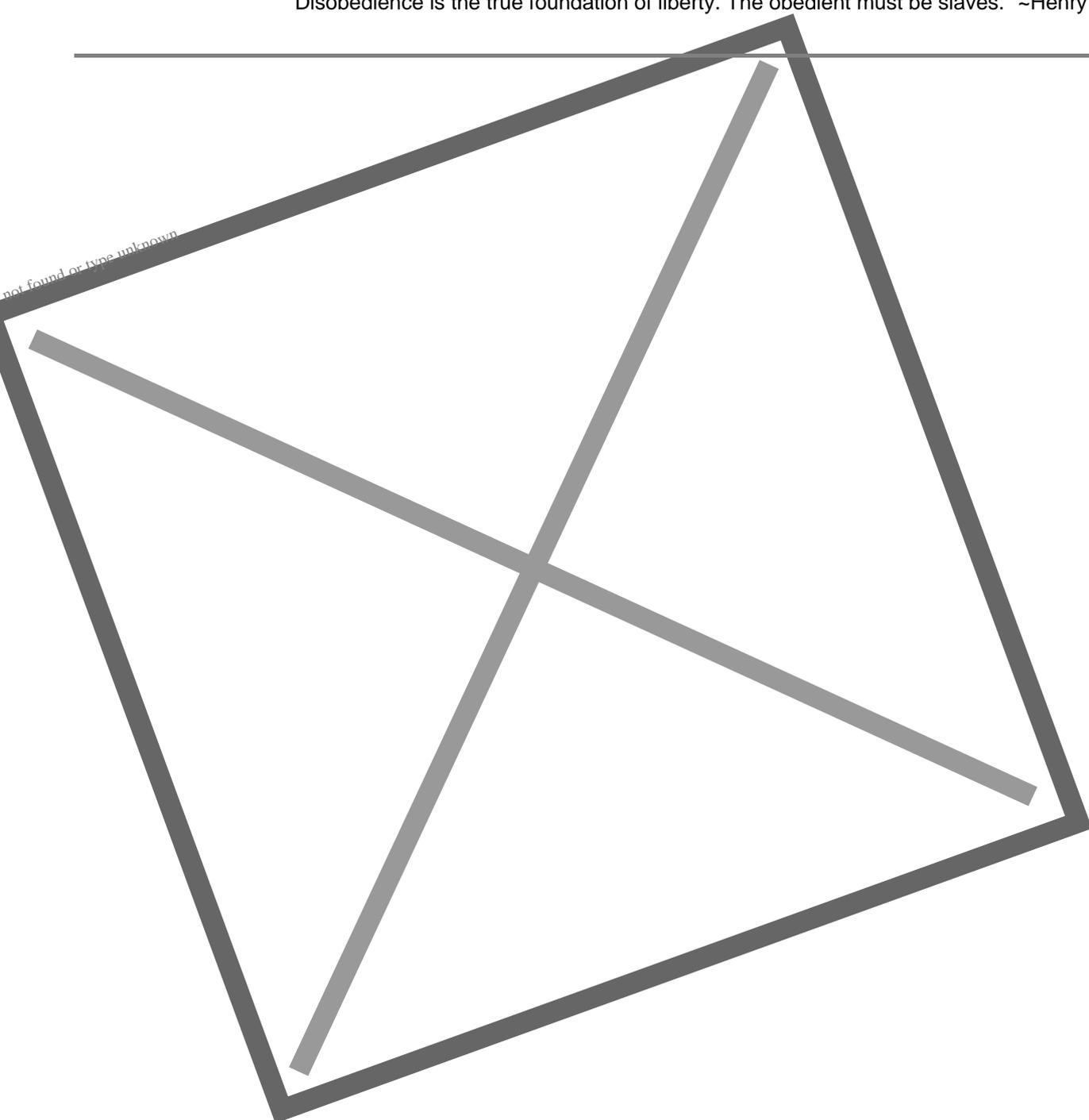


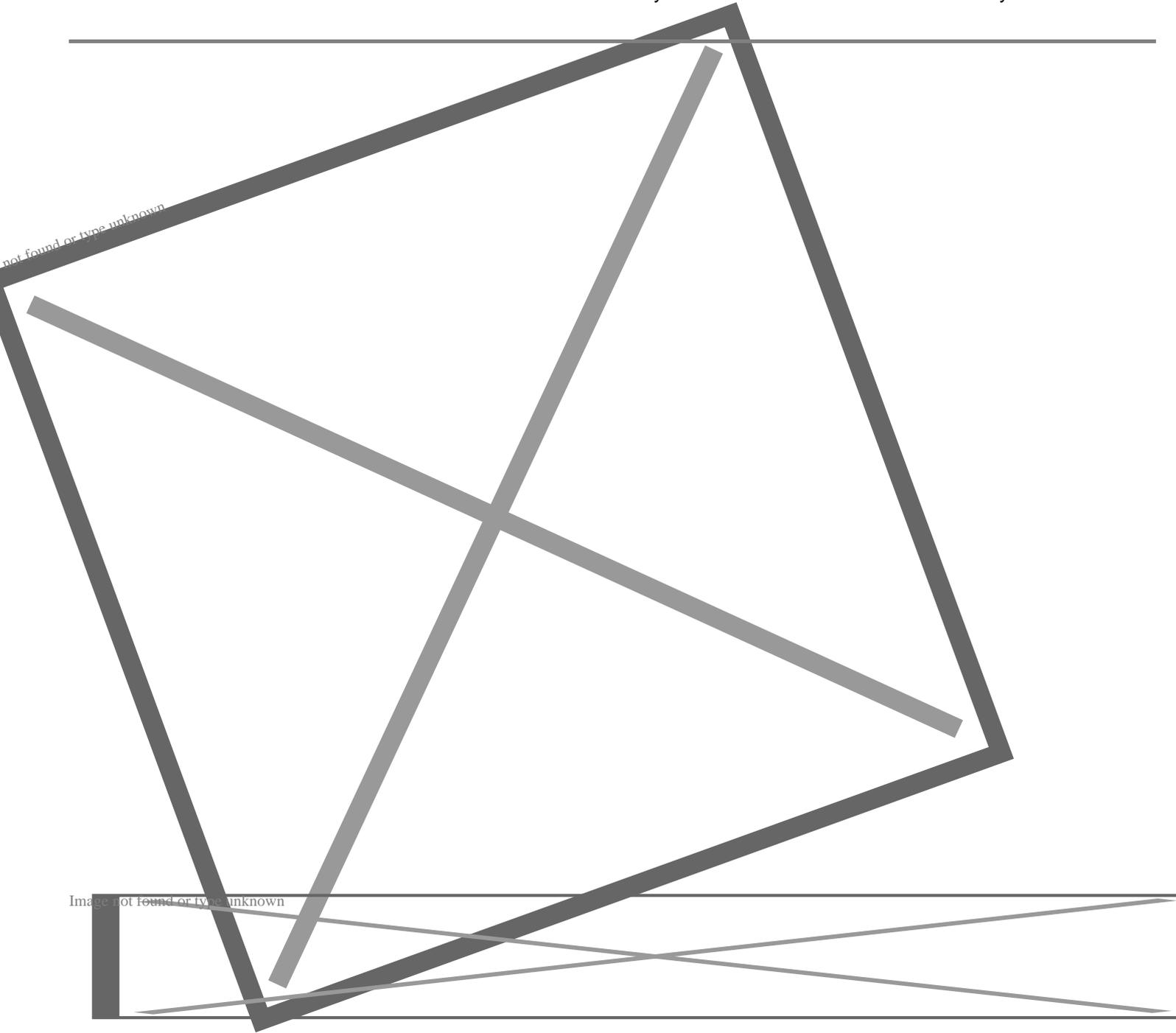
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"Disobedience is the true foundation of liberty. The obedient must be slaves." ~Henry David Thoreau

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Further References

Mulnix, J. W.. (2012). Thinking Critically about Critical Thinking. Educational Philosophy and Theory

Plain numerical DOI: 10.1111/j.1469-5812.2010.00673.x

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“As a philosophy professor, one of my central goals is to teach students to think critically. however, one

difficulty with determining whether critical thinking can be taught, or even measured, is that there is widespread disagreement over what critical thinking actually is. here, i reflect on several conceptions of critical thinking, subjecting them to critical scrutiny. i also distinguish critical thinking from other forms of mental processes with which it is often conflated. next, i present my own conception of critical thinking, wherein it fundamentally consists in acquiring, developing, and exercising the ability to grasp inferential connections holding between statements. finally, given this account of critical thinking, and given recent studies in cognitive science, i suggest the most effective means for teaching students to think critically. [abstract from author]"

Ennis, R. H.. (2011). The Nature of Critical Thinking : An outline of critical thinking dispositions. In Sixth International Conference on Thinking at MIT

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"Critical thinking is reasonable and reflective thinking focused on deciding what to believe or do. this definition i believe captures the core of the way the term is used in the critical thinking movement. in deciding what to believe or do, one is helped by the employment of a set of critical thinking dispositions and abilities that i shall outline. these can serve as a set of comprehensive goals for a critical thinking curriculum and its assessment. usefulness in curriculum decisions, teaching, and assessment, not elegance or mutual exclusiveness, is the purpose of this outline. for the sake of brevity, clarification in the form of examples, qualifications, and more detail, including more criteria, are omitted, but can be found in sources listed below, but most fully in my critical thinking (1996a). this outline is the encapsulation of many years of work in the elaboration of the simple definition of critical thinking given above, and it distinguishes between critical thinking dispositions and abilities. it is only a critical thinking content outline. it does not specify grade level, curriculum sequence, emphasis, teaching approach, or type of subject-matter content involved (standard subject-matter content, general knowledge content, streetwise-knowledge content, special knowledge content, etc.). for assessment purposes it can only provide a basis for developing a table of specifications and the preparation of assessment rubrics. critical thinking dispositions ideal critical thinkers are disposed to 1. care that their beliefs be true ii , and that their decisions be justified; that is, care to 'get it right' to the extent possible; including to a. seek alternative hypotheses, explanations, conclusions, plans, sources, etc.; and be open to them b. consider seriously other points of view than their own c. try to be well informed d. endorse a position to the extent that, but only to the extent that, it is justified by the information that is available e. use their critical thinking abilities 2. care to understand and present a position honestly and clearly, theirs as well as others'; including to a. discover and listen to others' view and reasons b. be clear about the intended meaning of what is said, written, or otherwise communicated, seeking as much precision as the situation requires c. determine, and maintain focus on, the conclusion or question d. seek and offer reasons e. take into account the total situation f. be reflectively aware of their own ..."

Kuhn, D.. (2007). A Developmental Model of Critical Thinking. Educational Researcher

Plain numerical DOI: 10.3102/0013189x028002016

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"The critical thinking movement, it is suggested, has much to gain from conceptualizing its subject matter in a developmental framework. most instructional programs designed to teach critical thinking

do not draw on contemporary empirical research in cognitive development as a potential resource. the developmental model of critical thinking outlined here derives from contemporary empirical research on directions and processes of intellectual development in children and adolescents. it identifies three forms of second-order cognition (meta-knowing) — metacognitive, metastrategic, and epistemological — that constitute an essential part of what develops cognitively to make critical thinking possible.”
Ennis, R. H.. (1993). Critical thinking assessment. Theory Into Practice

Plain numerical DOI: 10.1080/00405849309543594

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“Suggests that critical thinking assessment is difficult to do well, but it is possible. notes that difficulties and possibilities vary with the purpose of the assessment and the format used. after examining published critical thinking tests, the paper explains how to create customized tests. (sm)”

Richmond, B.. (1993). Systems thinking: Critical thinking skills for the 1990s and beyond. System Dynamics Review

Plain numerical DOI: 10.1002/sdr.4260090203

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“Focuses on the transfer of the technologies of systems thinking to the education system. information on systems dynamics and systems thinking; evolution of the education system; placement of the systems of thinking skills into critical thinking skills.”

Siegel, H.. (2010). Critical thinking. In International Encyclopedia of Education

Plain numerical DOI: 10.1016/B978-0-08-044894-7.00582-0

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“This article on critical thinking emphasizes its normative character. it explains what critical thinking is, why it is valuable, and why it is educationally basic. being a critical thinker is a matter of degree. critical thinking involves both skills and abilities of reason assessment, and the disposition to exercise those abilities; the critical thinker is both able to assess the probative strength of reasons, and is disposed to do so. such thinking satisfies relevant criteria of reason assessment. critical thinking is rightly regarded as a fundamental educational ideal, for reasons offered below. while there may be considerable merit in some criticisms of critical thinking, more radical challenges to it fail in that they in the end rely on the very critical thinking they aim to challenge. © 2010 elsevier ltd. all rights reserved.”

Pithers, R. T., & Soden, R.. (2000). Critical thinking in education: A review. Educational Research

Plain numerical DOI: 10.1080/001318800440579

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“National governments and employers have argued that it is important for all sectors of education to prepare individuals who are able to think well and for themselves. ‘good thinking’ and ‘thinking well’ are commonly used terms bound up with what is called ‘critical thinking’ in the research literature. evidence is pre- sented in this paper, however, which suggests that not all students may be good at critical thinking; nor do some teachers appear to teach students ‘good think- ing’ skills.a review of the research literature in this area was undertaken and the methods and conceptions of teaching likely to inhibit and enhance critical think- ing are outlined, as well as what is required to improve students’ thinking skills. ways forward in teaching critical thinking, and in helping students to learn to think well and for themselves, are described and discussed.”

Macke, J.. (1991). On Teaching Critical Thinking. Educational Philosophy and Theory

Plain numerical DOI: 10.1111/j.1469-5812.1991.tb00176.x

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“SignificanceUnderstanding and thinking critically about scientific evidence is a crucial skill in the modern world. we present a simple learning framework that employs cycles of decisions about making and acting on quantitative comparisons between datasets or data and models. with opportunities to improve the data or models, this structure is appropriate for use in any data-driven science-learning setting. this structure led to significant and sustained improvement in students’ critical thinking behaviors, compared with a control group, with effects far beyond that of statistical significance. the ability to make decisions based on data, with its inherent uncertainties and variability, is a complex and vital skill in the modern world. the need for such quantitative critical thinking occurs in many different contexts, and although it is an important goal of education, that goal is seldom being achieved. we argue that the key element for developing this ability is repeated practice in making decisions based on data, with feedback on those decisions. we demonstrate a structure for providing suitable practice that can be applied in any instructional setting that involves the acquisition of data and relating that data to scientific models. this study reports the results of applying that structure in an introductory physics laboratory course. students in an experimental condition were repeatedly instructed to make and act on quantitative comparisons between datasets, and between data and models, an approach that is common to all science disciplines. these instructions were slowly faded across the course. after the instructions had been removed, students in the experimental condition were 12 times more likely to spontaneously propose or make changes to improve their experimental methods than a control group, who performed traditional experimental activities. the students in the experimental condition were also four times more likely to identify and explain a limitation of a physical model using their data. students in the experimental condition also showed much more sophisticated reasoning about their data. these differences between the groups were seen to persist into a subsequent course taken the following

year.”

Bailin, S.. (2002). Critical thinking and science education. Science and Education

Plain numerical DOI: 10.1023/A:1016042608621

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“It is widely held that developing critical thinking is one of the goals of science education. although there is much valuable work in the area, the field lacks a coherent and defensible conception of critical thinking. as a result, many efforts to foster critical thinking in science rest on misconceptions about the nature of critical thinking. this paper examines some of the misconceptions, in particular the characterization of critical thinking in terms of processes or skills and the separation of critical thinking and knowledge. it offers a more philosophically sound and justifiable conception of critical thinking, and demonstrates how this conception could be used to ground science education practice.”

Sanders, M., & Moulenbelt, J.. (2011). Defining Critical Thinking. Inquiry: Critical Thinking Across the Disciplines

Plain numerical DOI: 10.5840/inquiryctnews20112616

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“Critical thinking is a skill that most teachers would readily agree is important for students to develop. unfortunately, many of our students have poorly developed critical thinking skills. perhaps the problem is rooted in those who teach. do teachers in career and technical education (cte) understand the concept of critical thinking well enough to teach students to think critically in and about the discipline being studied? good thinking skills will not develop on their own, they must be taught. teaching thinking skills is a difficult endeavor. teaching to promote thinking takes much time to prepare, is difficult to plan, and limits the amount of content ‘taught.’ teachers can no longer be information givers. on the other hand, students must learn thinking and reasoning skills to reach their fullest potential in today’s society. if we are to prepare students for entry and advancement in careers through cte, we must commit to developing problem solving and decision making through teaching critical thinking skills and developing the dispositions necessary to think critically.”

Jackson, M. C.. (2001). Critical systems thinking and practice. European Journal of Operational Research

Plain numerical DOI: 10.1016/S0377-2217(00)00067-9

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“Critical systems thinking and the methodologies associated with it were developed precisely to allow

analysis of complex societal problems and intervention to resolve such problems. early approaches employing systems ideas, such as operational research, systems analysis and systems engineering, were suitable for tackling certain well-defined problems, but were found to have limitations when faced with complex problems involving people with a variety of viewpoints and frequently at odds with one another. systems thinkers responded with approaches such as system dynamics and organizational cybernetics to tackle complexity; soft systems methodology (ssm) and interactive planning to handle subjectivity; and critical systems heuristics to help the disadvantaged in situations involving conflict. there was a corresponding enlargement of the range of problem contexts in which they felt competent to intervene. it has been critical systems thinking, however, which has supplied the bigger picture, has allowed systems thinking to mature as a discipline and has set out how the variety of methodologies now available can be used together in a coherent manner to promote successful intervention in complex societal problem situations. this paper outlines, at the request of the editor of this special issue, my involvement in developing critical systems thinking and practice, describes its origins, nature and use, and sets out a programme for future research in the area."

Bowell, T., & Kemp, G.. (2002). Critical Thinking: A Concise Guide. Philosophy

Plain numerical DOI: 10.1017/CBO9781107415324.004

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"We are frequently confronted with arguments. arguments are attempts to persuade us – to influence our beliefs and actions – by giving us reasons to believe this or that. critical thinking: a concise guide will equip students with the concepts and techniques used in the identification, analysis and assessment of arguments. through precise and accessible discussion, this book provides the tools to become a successful critical thinker, one who can act and believe in accordance with good reasons, and who can articulate and make explicit those reasons. key topics discussed include: core concepts in argumentation how language can serve to obscure or conceal the real content of arguments; how to distinguish argumentation from rhetoric how to avoid common confusions surrounding words such as 'truth', 'knowledge' and 'opinion' how to identify and evaluate the most common types of argument how to distinguish good reasoning from bad in terms of deductive validity and induction. this fourth edition has been revised and updated throughout, with a new introduction for each chapter and up-to-date topical examples. particular revisions include: practical reasoning; understanding quantitative data, statistics, and the rhetoric used about them; scientific reasoning; the connection to formal logic and the logic of probability; conditionals; ambiguity; vagueness; slippery slope arguments; and arguments by analogy. the dynamic routledge critical thinking companion website provides thoroughly updated resources for both instructors and students including new examples and case studies, flashcards, sample questions, practice questions and answers, student activities and a testbank of questions for use in the classroom."

Duron, R., Limbach, B., & Waugh, W.. (2006). Critical Thinking Framework For Any Discipline. International Journal of Teaching and Learning in Higher Education

Plain numerical DOI: 10.1016/j.nepr.2006.09.004

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"This paper identifies a 5-step framework that can be implemented in virtually any teaching or training setting to effectively move learners toward critical thinking. this interdisciplinary model, which is built upon existing theory and best practices in cognitive development, effective learning environments, and outcomes-based assessment, provides teachers with a useful framework. this framework can be used to move students toward a more active-learning environment which, ultimately, is more enjoyable and effective for teachers and students alike. an example of the model is applied in the context of accounting education, which represents a business discipline in which critical thinking has been consistently cited as both necessary and difficult to implement. thinking is a natural process, but left to itself, it is often biased, distorted, partial, uninformed, and potentially prejudiced; excellence in thought must be cultivated (scriven and paul, 2004). critical thinking is, very simply stated, the ability to analyze and evaluate information. critical thinkers raise vital questions and problems, formulate them clearly, gather and assess relevant information, use abstract ideas, think open-mindedly, and communicate effectively with others. passive thinkers suffer a limited and ego-centric view of the world; they answer questions with yes or no and view their perspective as the only sensible one and their facts as the only ones relevant. critical thinking is an important and necessary skill because it is required in the workplace, it can help you deal with mental and spiritual questions, and it can be used to evaluate people, policies, and institutions, thereby avoiding social problems (hatcher and spencer, 2005). this paper identifies a 5-step framework that can be implemented in virtually any teaching or training setting to effectively move learners toward critical thinking. this interdisciplinary model, which is built upon existing theory and best practices in cognitive development, effective learning environments, and outcomes-based assessment, provides teachers with a useful framework in which to move students and lecture-based courses toward an active-learning environment. techniques that encourage critical thinking"

Bailin, S., Case, R., Coombs, J. R., & Daniels, L. B.. (1999). Conceptualizing critical thinking. *Journal of Curriculum Studies*

Plain numerical DOI: 10.1080/002202799183133

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"In this paper, the second of two, we set out a conception of critical thinking that critical thinking is a normative enterprise in which, to a greater or lesser degree, we apply appropriate criteria and standards to what we or others say, do, or write. the expression 'critical thinking' is a normative term. those who become critical thinkers acquire such intellectual resources as background knowledge, operational knowledge of appropriate standards, knowledge of key concepts, possession of effective heuristics, and of certain vital habits of mind. we explain why these intellectual resources are needed and suggest that we can best teach critical thinking by infusing it within any curricular practice in which our students are involved. [abstract from author]"

Mason, M.. (2009). *Critical Thinking and Learning*. Critical Thinking and Learning

Plain numerical DOI: 10.1002/9781444306774

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“By introducing current debates in the field of critical thinking and posing new questions from contributing scholars, critical thinking and learning examines the received wisdom in the field of critical thinking and learning. examines the different perspectives in the field of critical thinking and learning provides insights into critical thinking by posing new questions from contributing authors introduces cross-cultural viewpoints into the dominant 'western'-based educational viewpoint highlights differences among a variety of thinkers in the field. © 2008 the authors.”

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