



*Mersin Üniversitesi Dil ve Edebiyat Dergisi, MEUDED, 2015; 12 (1): 43-61.*

## ASSOCIATIVE MEASURES AND MULTI-WORD UNIT EXTRACTION IN TURKISH

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**Abstract:** Associative measures are “mathematical formulas determining the strength of association between two or more words based on their occurrences and cooccurrences in a text corpus” (Pecina, 2010, p. 138). The purpose of this paper is to test the 12 associative measures that Text-NSP (Banerjee & Pedersen, 2003) contains on a 10-million-word subcorpus of Turkish National Corpus (TNC) (Aksan et.al., 2012). A statistical comparison of those measures is out of the scope of the study, and the measures will be evaluated according to the linguistic relevance of the rankings they provide. The focus of the study is basically on optimizing the corpus data, before applying the measures and then, evaluating the rankings produced by these measures as a whole, not on the linguistic relevance of individual n-grams. The findings include intra-linguistically relevant associative measures for a comma delimited, sentence splitted, lower-cased, well-balanced, representative, 10-million-word corpus of Turkish.

**Keywords:** *Multi-word units, associative measures, Turkish National Corpus*

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Makale gönderim tarihi: 5 Mart 2015 ; Kabul tarihi: 2 Nisan 2015

## BİRLİKTELİK ÖLÇÜLERİ VE TÜRKÇEDE ÇOKSÖZCÜKLÜ BİRİM ÇIKARIMI

**Öz:** Birliktelik ölçüleri “bir dil derleminde, iki ya da daha fazla sözcük arasındaki ilinti gücünün, tek tek ve birlikte kullanımları temelinde belirlenmesinde kullanılan matematiksel formüllerdir” (Pecina, 2010). Bu makalenin amacı da Text-NSP (Banerjee & Pedersen, 2003) adlı yazılımın içerdiği 12 birliktelik ölçüsünü, Türkçe Ulusal Derlemi’nin (Aksan vd., 2012) veritabanlarından oluşturulan, 10 milyon sözcüklük bir alt-derlemde sınamaktır. Bu ölçülerin istatistik yöntemlerle karşılaştırılması çalışmanın kapsamı dışındadır. Bu yazı kapsamında sınanan birliktelik ölçüleri, oluşturdukları sıralamanın dil-içi uygunluğuna göre değerlendirilecektir. Çalışmanın odağında, istatistik ölçülerin uygulanması öncesinde derlem verisinin iyileştirilmesi ve ölçülerin uygulanması sonrasında oluşan sıralamaların, tek tek çok sözcüklü birimlerin uygunluğuna göre değil, sayısal sıralamanın dil-içi uygunluğa göre değerlendirilmesi vardır. Çalışmanın bulguları; virgülle sınırlanmış, tümcelerine ayrılmış, küçük harfe çevrilmiş, dengeli ve temsil yeterliği olan 10 milyon sözcüklük Türkçe bir derlem için dilbilimsel olarak uygun birliktelik ölçülerini içermektedir.

**Anahtar sözcükler:** *Çok sözcüklü birim, birliktelik ölçüsü, Türkçe Ulusal Derlemi*

### 1. INTRODUCTION

Jackendoff (1997) notes that the number of MWUs in a speaker’s lexicon is of the same order of magnitude as the number of single words. Although we do not have any statistical estimation for the amount of MWUs in Turkish lexicon, the importance of these lexical units can be figured out with their proportion in English lexicon. For instance, as Ramisch et.al. (2013) notes, among the nouns in WordNet, 60.292 of the total 117,827 (51.4%) are MWUs and for the verbs, the proportion is 25.5% (2,829 among 11,558).

In this respect, there is a strong need for studies on MWU extraction in Turkish and the intra-linguistic properties of those MWUs, considering the fact that the overall proportion of MWUs in current Turkish lexicon appears to be greater than documented in dictionaries. Only after forming a preliminary, gold standard MWU set for Turkish, it could be possible for researchers to evaluate their statistical or

linguistic methods and to improve the documentation of Turkish lexicon.

### 1.1. THEORETICAL BACKGROUND

Sinclair's (1991) "idiom principle" which asserts that we have a tendency to use MWUs, rather than storing and processing words individually, is the main assumption of this study. As Sinclair (ibid.) states, "the principle of idiom is that a language user has available to him or her a large number of semi-preconstructed phrases that constitute single choices, even though they might appear to be analysable into segments". Our definition of MWUs also follows Sinclair in the sense that they include not only well-known idioms as presented in current Turkish dictionaries but also other preconstructed "phrasemes" (Mel'čuk, 1995, p. 168).

In short, as Mel'čuk (1995, p. 169) states, "people speak not in words but in phrases" and for Turkish, even a preliminary, well-documented MWU lexicon has not been made available to public yet, which would also be a valuable resource for other rich-morphology languages.

### 1.2. SCOPE

The focus of this study is not on 'statistical' requirements, comparisons, optimizations or assessment of associative measures but on 'intra-linguistic, phraseological' relevance of the rankings provided by them, applied on a well-balanced, representative corpus of Turkish. Corpus-driven, directional (Evert, 2004) collocate extraction practices for pre-defined query words are off the scope of current study. It is limited to symmetrical n-gram rankings and their intra-linguistic validation for further studies in Turkish.

The study is limited to 2, 3 and 4-grams and the 12 associative measures in the package Text-NSP v1.27 (Banerjee & Pederson, 2003). Broader units or the identification of part-whole relationships between n and n+1 grams are excluded from the study.

Limitations of the software, if any (i.e. formulas, procedures or the code), are preserved as-is.

## 2. CURRENT TRENDS IN MWU EXTRACTION

Combining more than one association measure (Pecina, 2010) or applying each measure for a single grammatical pattern (Nissim & Zaninello, 2013) are the two current trends in MWU extraction. The later hybrid approach is highly adaptable to Turkish since it combines both grammatical filtering and statistical ranking. A classification of annotated n-grams according to their grammatical patterns, before applying any statistical measures, is proven to be productive for identifying MWUs, especially in a candidate set which consists of inflected forms of the same unit as the case for the agglutinative languages.

Rayson et.al. (2010, p. 2) also state that “it has become increasingly obvious that, in order to develop more efficient algorithms, we need deeper understanding of the structural and semantic properties of MWEs, such as morpho-syntactic patterns, semantic compositionality, semantic behaviour in different contexts, cross-lingual transformation of MWE properties etc.”. As stated above, the development of efficient measures is only possible by focusing or operating on some morpho-syntactic classifications. Since associative measures are language-specific, experimenting on the measures applied on another language (mostly English) and expecting similar results is not a productive approach for Turkish.

## 3. MWU EXTRACTION IN TURKISH

Preliminary works on MWU extraction in Turkish - the first following a rule-based approach and the later a statistical one - are (Oflazer et.al., 2004) and (Kumova-Metin & Karaoğlan, 2010).

Oflazer et.al (2004) argue that MWUs –actually two-word MWUs- can be classified into *lexicalized*, *semi-lexicalized* and *non-lexicalized* units. However, since the extraction rules are based on a limited set, namely *light verb constructions* and *reduplications*, which are - by definition - the most frequent MWU forms in bigrams but not representative for further 3, 4-word MWUs, this classification is based on practical purposes rather than linguistic. In addition, the rules –although not documented properly- are designed to identify that limited set of grammatical patterns which are easier to define in

regular expressions. We cannot solely rely on grammatical patterns in that sense, considering the varying internal, grammatical properties of MWUs, if not limited to bigrams.

Kumova-Metin and Karaođlan (2010) state that Mutual Information and Chi-square are the two relevant measures for Turkish. This study, on the other hand, is strictly based on statistical measures to extract MWUs and thus ignores the occurrences of the same MWUs in different inflectional word forms by evaluating each inflectional variety as separate units.

The present study will demonstrate the results of statistical measures on a comma delimited, sentence splitted, lower-cased corpus. The findings of the study, can also be optimized in further studies following a hybrid approach, which combines a grammatical classification as the first step and a relevant statistical ranking as the second.

Formulaicity in Turkish is also discussed in Durrant & Matthew-Aydınlı (2011) focusing on academic texts. As another genre-based approach, Aksan and Aksan (2013) provide a linguistic classification of MWUs in fiction and informative texts in terms of their grammatical patterns and discourse functions. This study is also valuable in being the first to have a representative, well-balanced corpus of Turkish as the data source. As a study on processes of symmetrical and directional MWU extraction, Mersinli and Demirhan (2012) demonstrate a case study on Primary School Turkish Language Teaching Coursebooks.

When the above mentioned studies are considered, it is apparent that hybrid approaches combining grammar-based filtering and statistical ranking will be the forthcoming trend in Turkish MWU extraction. Genre-based studies will also provide valuable findings and data for further studies.

#### 4. DATA AND METHODOLOGY

##### 4.1. OPERATIONAL DEFINITIONS

**Multi-Word Unit (MWU):** The “non-compositional”, “non-modifiable” and “non-substitutable” (Manning & Schütze, 2001, p. 184) word co-occurrences that are stored and processed as a single unit in mental lexicon. Since, the above mentioned characteristics do not have clear boundaries in all languages and MWUs are ‘mostly’ non-compositional, non-modifiable and non-substitutable, and also idiosyncratic; boundaries between a MWU and a syntactic phrase is highly dependent on the evaluator. As Calzolari (2002, p. 1934) states, MWUs “defy naïve attempts to establish a border between grammar and lexicon in terms of the opposition between rule productivity and lexical idiosyncrasy”. Thus, in this study, the term ‘multi-word unit’ will refer to any fixed word sequences that can be processed as a single unit while preparing a dictionary. Wray (2002) discusses more than 50 terms referring to formulaic language use but discussing the varying terminological choices is out of the scope of current study.

**N-gram:** all co-occurrences –either lexicalized or not- of two or more words recurring in a corpus and extracted from a corpus as MWU candidates. N refers to the number of words included.

**Word:** A “fuzzy”, “language-specific” (Haspelmath, 2011) concept which cannot be an operational unit cross-linguistically. A given word in a language can be an affix in another language, as the case for English and Turkish. Thus, in this study, “word” refers to any sequence of characters defined as tokens in a corpus, in other words, an orthographical unit rather than a linguistic one, delimited with space characters or certain punctuation marks.

**Associative measures:** “Mathematical formulas determining the strength of association between two or more words based on their occurrences and cooccurrences in a text corpus” (Pecina, 2010, p. 138). These formulas provide n-gram rankings as an initial step for MWU extraction.

#### 4.2. THE CORPUS

The data of the study is derived from a 10-million-word sub-corpus (TNC-Baby) following the design features of Turkish National Corpus (<http://www.tnc.org.tr>) and covering a period of 20 years (1990-2009). The sub-corpus preserves the quantificational distribution of TNC in terms of text domains, time and medium of texts.

Textual data in the sub-corpus is optimized for practical purposes and the ASCII formatted, sentence splitted, comma delimited, lower-cased text is processed on a Windows PC with Turkish as the system language, and Perl v.5.16.2. Table 1 presents the optimization process. Excluding the punctuation marks as non-tokens is a well-known practice in similar studies. Our proposal is that noise-reduction or excluding ill-formed MWU candidates should also be included in the pre-formatting of corpus data, before applying any measure. A comma delimited text, for instance, will exclude irrelevant ngrams and may provide less noisy rankings.

**Table 1.** Optimizing corpus data for MWU extraction

**original, sentence-splitted text**

Ekoloji  
YAPRAK DÖKÜNTÜLERİNDE FUNGAL SUKSESYON  
Bu makalede, çam yaprakları ve diğer ağaç yapraklarının  
çürümeleleri anlatılmıştır.

**optimized version (lower-cased, comma delimited)**

ekoloji  
yaprak döküntülerinde fungal sukcesyon  
bu makalede  
çam yaprakları ve diğer ağaç yapraklarının çürümeleleri  
anlatılmıştır.

### 4.3. SOFTWARE

The Perl package Text-NSP v1.27 is used to rank the n-grams according to their observed frequency (count.pl) and to compute 12 associative measures (statistic.pl). For practical purposes, the line ‘use locale,’ is added to the Perl code, both for count.pl and statistic.pl modules, to handle Turkish-specific characters in ASCII formatted corpus data. Table 2 summarizes the usage of the package, where ‘ignore.txt’ includes the punctuation marks not to be regarded as tokens and ‘remove 10’ declares the cut-off point simply to exclude n-grams occurring less than 10 times in the corpus.

**Table 2.** Usage of Text-NSP v1.27

```
perl count.pl -ngram 2 -nontoken ignore.txt -newLine -remove 10
output1.count corpus.txt
perl statistic.pl --ngram 2 Text::NSP::Measures::2D::CHI::tscore
output2.txt output1.count
```

### 4.4. ASSOCIATIVE MEASURES

The 12 measures in Table 3 are the set of associative measures evaluated.

**Table 3.** The Measures of Association Provided in Text-NSP v.1.27

<b>2-gram measures</b>	<b>Abbreviation</b>
Dice Coefficient	dice
Fishers exact test - left sided	left
Fishers exact test - right sided	right
Fishers exact test - two tailed	twotailed
Jaccard Coefficient	jaccard
Log-likelihood ratio	ll
Mutual Information	mi
Pointwise Mutual Information	pmi
Phi Coefficient	phi

Pearson's Chi Squared Test	x2
Poisson Stirling Measure	ps
T-score	tscore
<b>3-gram measures</b>	<b>Abbreviation</b>
Log-likelihood ratio	ll
Mutual Information	mi
Pointwise Mutual Information	pmi
Poisson Stirling Measure	ps
<b>4-gram measures</b>	<b>Abbreviation</b>
Log-likelihood ratio	ll

#### 4.5. EVALUATION OF THE MEASURES

The relevance of associative measures for n-gram ranking is often measured statistically by calculating precision, recall or f-measure (the combination of precision and recall) values which is not the preferred technique in this study. The rationale for this preference is that, besides being data or language specific, those values rely on whether the ranked n-grams are valid MWUs or not, which is problematic for Turkish having no standard, representative MWU datasets published for such validation.

In addition, according to Pecina (2010), eliciting the best association measure for MWU extraction depends heavily on data, language, and the notion of MWU itself. As Hiemstra & Kraaij (2007, p. 356) state, “it takes more discipline to perform a really blind experiment and extra care not to tune on the *-statistical-* data”.

MWU extraction is a semi-automatic, corpus-based Natural Language Processing (NLP) practice that includes ranking and filtering n-grams which validate pre-defined statistical and/or linguistic criteria. Those pre-defined criteria leads to data modification to some extent (e.g.

thresholds or the reference MWU sets) and thus prevent the MWU extraction studies from being fully automatic processes without any intervention by the researcher.

To summarize, our argument for the evaluation of associative measures is that any measure can be considered as valid, depending on the following criteria.

- i. the purpose  
(i.e., extracting Light Verb Constructions, Named Entities or Discourse Connectives, Postpositional Phrases, Genitive-Possessive constructions, Compound Nouns etc or even extracting non-MWUs)
- ii. the language (e.g., isolating or agglutinative)  
(i.e., a word in an isolating language would possibly be the equivalent of a suffix and thus the measures themselves are again language-specific)
- iii. unit of interest  
(i.e. types, lemmas, suffixes or their combinations)
- iv. data  
(i.e. a well-balanced, representative reference corpus versus a genre-specific web-based text archive)
- v. statistical data modifications  
(i.e. setting the optimum thresholds for high precision, recall values)

With respect to the above mentioned considerations, our evaluation will be based on a single validation unit for 2-grams, namely *ya da* “or”, a variant of *veya* in Turkish. That single MWU serves as an evaluator for the rankings of the measures subject to the study provided, because, without doubt, any ranking should start with that MWU if the data source is representative for Turkish, especially considering the finding that top-rated n-gram provided by the measures evaluated is either *ya da* “or” or *teker teker* “one by one”. This distinction makes the rankings starting with *teker teker*, irrelevant for general MWU extraction, regarding the huge difference in the observed frequency values of the two.

The rationale behind using such a positive evidence for valid MWU rankings is just similar to the use of stop words that cannot initialize or finalize a MWU in Turkish – e.g. *ve* “and”, *de, da* “too” or *bir* “a, an” - as a negative evidence for identifying false positives within a ranking.

On the other hand, for 3-grams, *ya da* “or”, serves as a negative evidence for invalid rankings, since any relevant ranking should not start with 3-grams with an initial *ya da* “or” sequence as in Table 4.

**Table 4.** Examples for irrelevant 3-gram rankings

	<b>Log-likelihood</b>	<b>True mutual information</b>
1	ya da bu	ya da bu
2	ya da başka	ya da başka
3	ya da böyle	ya da böyle
4	ya da olumsuz	ya da olumsuz
5	ya da benim	ya da kişisel
6	ya da kişisel	ya da benim
7	ya da ne	ya da daha
8	ya da daha	ya da ne
9	ya da diğer	ya da diğer
10	ya da onun	ya da onun
11	ya da bana	ya da en
12	ya da birkaç	ya da birkaç
13	ya da en	ya da bana
14	ya da kendi	ya da yeni
15	ya da yeni	ya da kendi
16	ya da dolaylı	ya da çok
17	ya da her	ya da hiç
18	ya da çok	ya da her

19	ya da yanlış	ya da özel
20	ya da özel	ya da dolaylı

For 4-grams, the evaluation is based on no pre-defined stop-lists since log-likelihood is the only associative measure applicable to 4-grams in Text-NSP. Thus, only an overall evaluation of top-20 4-grams ranked by that measure will be presented in the study.

## 5. FINDINGS AND DISCUSSION

### 5.1. BIGRAMS

Only 5 of the 12 associative measures, namely T-score, Fisher's exact test (left-sided), Log-likelihood, True Mutual Information and Poisson-Stirling, provided valid rankings starting with *ya da* "or" for bigrams. Table 5 presents the top-20 ranked MWU candidates for each measure. Abbreviations for the measures are the ones stated in Table 3.

**Table 5.** Valid associative measures for 2-grams and top-20 MWU candidates.

	<b>tscore</b>	<b>left</b>	<b>ll &amp; tmi</b>	<b>ps</b>
1	ya da	ya da	ya da	ya da
2	hem de	ve bu	söz konusu	söz konusu
3	bir şey	bir şey	hem de	hem de
4	ne kadar	hem de	bir bir	aynı zamanda
5	böyle bir	böyle bir	aynı zamanda	olmak üzere
6	söz konusu	büyük bir	olmak üzere	ne kadar
7	büyük bir	ne kadar	bir ve	ile ilgili
8	bu nedenle	önemli bir	ne kadar	yer alan
9	başka bir	başka bir	ile ilgili	yanı sıra
10	ben de	yeni bir	yer alan	öte yandan
11	daha çok	bir şekilde	yanı sıra	daha fazla

12	önemli bir	daha çok	öte yandan	son derece
13	aynı zamanda	söz konusu	bu nedenle	değil mi
14	ile ilgili	ben de	böyle bir	bu nedenle
15	daha fazla	bu nedenle	daha fazla	olduğu gibi
16	o zaman	bir başka	son derece	pek çok
17	yeni bir	herhangi bir	ve ve	ortaya çıkan
18	olduğu gibi	daha sonra	değil mi	en önemli
19	olmak üzere	bir süre	belki de	sık sık
20	herhangi bir	o zaman	bir şey	belki de

Almost all previous studies on MWU extraction in Turkish focus basically on 2-grams. The number of associative measures that are applicable to bigrams make them interesting for statistical reasons. However, 3-grams are more productive for MWU formation in Turkish since their morpho-syntactic content includes all the required components - i.e. heads, modifiers and specifiers - to form a closed syntactic projection. Linguistically speaking, as stated in Aksan & Aksan (2013), 3-grams are more relevant candidates for MWU extraction in Turkish. Thus, statistically oriented discussions or evaluations based on 2-grams and excluding further units make those findings specific to 2-grams, not for Turkish MWUs in general.

Another problem, more specific to 2-grams is that most of them are parts of larger units in Turkish, mostly 3-grams. Those fragmental 2-grams form the majority of the noisy data. However, it's a cross-linguistic problem, especially for 2-gram MWU candidates and substring reduction is another current trend in MWU extraction studies. As O'Donnell (2011, p. 136) states

“A common methodological step in a corpus linguistic analysis is the extraction of frequency lists of various size chunks (variously called clusters, lexical bundles or n-grams). Most software packages facilitate the creation of such lists, making it possible to compare units of different length. However, each size unit is (necessarily) counted on

its own terms without reference to larger units of which they may be a part.”

In addition, ignoring part-whole relationships in any frequency-based lexical data is not a problem specific to MWU extraction. All word frequencies, for instance, also include the occurrences of those words in broader MWUs. In this respect, reducing the noise caused by fragmental data at any level in lexical statistics is a broader problem and thus, out of the scope of current study.

As stated in Section 4.5., our primary argument, following Pecina (2010), is that any measure can be relevant depending on your purpose. In this sense, all the evaluations above are about 2-grams for ‘general’ MWU extraction in Turkish.

We argue that invalid associative measures for 2-grams can also be used for specific purposes. For example, the measures Dice coefficient, Jaccard, Phi Coefficient and Pearson's Chi Squared Test provided identical rankings with reduplications on top. More specifically, 92 of the top 200 bigrams ranked by those measures are reduplications. Table 6 presents the top-50 reduplications and their rankings with the above measures.

**Table 6.** Reduplications ranked by Dice coefficient, Jaccard, Phi Coefficient and Pearson's Chi Squared Test

teker teker (1), irili ufaklı (4), peş peşe (5), kayıtsız şartsız (6), uçsuz bucaksız (7), apar topar (9), ışıl ışıl (10), cıvıl cıvıl (14), koşa koşa (16), seve seve (17), burun buruna (18), tır tır (19), doya doya (24), gürül gürül (25), cık cık (27), gizliden gizliye (28), boşu boşuna (29), omuz omuza (30), hüngür hüngür (31), topu topu (34), vah vah (35), içli dışlı (36), sağda solda (37), allak bullak (38), harıl harıl (40), kuşaktan kuşağa (41), kesik kesik (42), körü körüne (43), diri diri (48), mışıl mışıl (49), enine boyuna (54), haşır neşir (55), didik didik (56), kıpır kıpır (57), inceden inceye (61), canla başla (65), kıs kıs (68), tıklar tıklar (76), aşağıdan yukarıya (78), bitmez tükenmez (80), vura vura (81), abuk sabuk (82), iner inmez (83), dalgın dalgın (84), derme çatma (87), kıran kırana (88), cayır cayır (90), döne döne (93), oluk oluk (98), havadan sudan (99)
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Finally, Fishers exact test (right sided and two tailed) provided irrelevant rankings in contrast with left-sided Fisher's and are worth considering for future comparisons or identifying non-MWUs.

## 5.2. TRIGRAMS

The only valid 3-gram rankings for general MWU extraction in Turkish is provided by Poisson-Stirling measure. As presented in Section 3.5., Log-likelihood and True Mutual Information rankings, starting all with *ya da* "or" are considered to be invalid for general MWU extraction from 3-gram candidates. Table 7 compares the Poisson-Stirling rankings with the observed frequencies of 3-grams. Regarding the fact that most of the MWUs in Turkish can be extracted from 3-grams, and the limitations of statistical measures, we can argue that observed frequencies are also valuable at 3-gram level.

**Table 7.** Valid rankings for 3-grams and top-20 MWU candidates.

	<b>observed freq.</b>	<b>ps</b>
1	bir süre sonra	ne var ki
2	bir kez daha	ne yazık ki
3	ne var ki	her ne kadar
4	her ne kadar	bir kez daha
5	başka bir şey	ne olursa olsun
6	ne yazık ki	bir süre sonra
7	bir yandan da	her şeyden önce
8	çok önemli bir	başka bir şey
9	bir an önce	bir an önce
10	ne olursa olsun	başta olmak üzere
11	kısa bir süre	kısa bir süre
12	her şeyden önce	bir yandan da
13	ya da bir	radyo ve televizyon
14	başka bir deyişle	ses kalitesi okuma

15	çok büyük bir	ile ilgili olarak
16	daha önce de	buna bağlı olarak
17	bir başka deyişle	dahil olmak üzere
18	böyle bir şey	her geçen gün
19	ile ilgili olarak	ama yine de
20	ya da bu	daha önce de

### 5.3. FOUR-GRAMS

Below are the Log-likelihood rankings and the observed frequencies of 4-gram MWU candidates. Due to the number of measures applicable for 4-grams, stop-word filtering (e.g. “ve”, “da”) can be used as the first step for general MWU extraction from 4-gram candidates.

**Table 8.** Top-20 MWU candidates ranked by log-likelihood and observed frequencies.

	<b>Raw</b>	<b>ll</b>
1	kısa bir süre sonra	ve bir süre sonra
2	başka bir şey değildir	kısa bir süre sonra
3	şu ya da bu	kısa bir süre için
4	ve buna bağlı olarak	kısa bir süre önce
5	her zaman olduğu gibi	kısa bir süre içinde
6	petrol ve doğal gaz	başka bir şey değildir
7	bir o kadar da	bir ya da iki
8	g e g için	bir ya da birkaç
9	başbakan recep tayyip erdoğan	ama bir süre sonra
10	de dahil olmak üzere	kısa bir süre içerisinde
11	türkiye büyük millet meclisi	bir ya da birden
12	iş doyumu ve yaşam	da bir süre sonra

13	ama ne yazık ki	de bir süre sonra
14	ne var ki bu	belli bir süre sonra
15	küçük ve orta ölçekli	şu ya da bu
16	özel radyo ve televizyon	başka bir şey yok
17	doyumunu ve yaşam doyumunu	ve bir o kadar
18	kısa bir süre önce	ve bir kez daha
19	ya da başka bir	geçici bir süre için
20	çok kısa bir süre	başka bir şey değildi

## 6. CONCLUSION

Table 9 summarizes the associative measures validated linguistically for general MWU extraction in Turkish.

**Table 9.** Valid associative measures for general MWU extraction in Turkish

2-grams	T-score, Fisher's Exact Test (left-sided), Log-likelihood, True Mutual Information, Poisson-Stirling Measure
3-grams	Poisson-Stirling Measure
4-grams	Log-likelihood

According to the findings above and considering the fact that 3-grams should be of special interest for MWU extraction in Turkish, we can argue that associative measures should be used with a preceding or following grammatical filtering stage and a hybrid approach combining rule based and statistical techniques is a necessity if not a must in Turkish. As discussed in Aksan et.al. (2015), a grammatical classification before applying any statistical measure, can exclude most of the non-MWUs from an n-gram ranking, since they will not validate the morphosyntactic constraints as presented in (1-2).

## (1) ADJECTIVE\_DETERMINER\_NOUN

*kısa bir süre* “a short time”*belli bir süre* “a limited time)

## (2) \* PRONOUN\_NOUN+loc\_NOUN

*bu sınavda başarı* “success in this exam”*bu konuda fikir* “argument on this topic”

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